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(U.S.) Environmental Protection Agency
Denver, CO Region VIII

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ATTACHMENT TO FINAL ENVIRONMENTAL IMPACT STATEMENT

UPPER EAGLE VALLEY AND VAIL WASTEWATER FACILITIES PLAN

OCTOBER 1977

U.S. Environmental Protection Agency
Region VIII
Denver, Colorado

REPRODUCED BY
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ATTACHMENT TO

FINAL ENVIRONMENTAL IMPACT STATEMENT

UPPER EAGLE AND VAIL WASTEWATER FACILITIES PLAN

Prepared by
U.S. Environmental Protection Agency
Region VIII - Denver, Colorado

October 1977

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The purpose of this report is to present the possible environmental impacts of a wastewater treatment facility plan for eastern Eagle County, 120 miles (193 kilometers) west of Denver, Colorado. The proposed federal action is the award of an EPA grant for partial funding of wastewater treatment works in Eagle County. This option is weighed against a no action alternative, as well as compared to other possible alternatives.

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I. THE EXISTING ENVIRONMENT

INTRODUCTION

The purpose of this report is to present the possible environmental impacts of a wastewater treatment facility plan for eastern Eagle County, 120 miles (193 kilometers) west of Denver, Colorado. The Environmental Protection Agency (EPA) has, in conformance with the National Environmental Policy Act, prepared the following Environmental Impact Statement (EIS). The proposed federal action is the award of an EPA grant for partial funding of wastewater treatment works in Eagle County. This option must be weighed against a no action alternative (no EPA funding), as well as compared to other possible solutions.

In 1972 Congress passed amendments to the Federal Water Pollution Control Act establishing national water quality goals. The Act included two parts: first, it provided for grants to fund planning and construction to abate water pollution and, second, it provided for the regulation of all point discharges through the National Pollution Discharge Elimination System (NPDES). Each discharge permit contains limitations which reflect standards established by EPA and/or the states. In addition, the Act provided federal monies for areawide water quality management under section 208. The emphasis of the 208 planning program is on control of non-point pollution sources as well as point source pollution, the latter being the principal subject of this environmental statement. Presently, the Northwest Colorado Council of Governments is developing a 208 plan for the counties of Pitkin, Eagle, Summit, Grand, Jackson, and Routt. A draft 208 water quality management plan for these counties is expected to be completed during the fall of 1977.

The selection of eastern Eagle County for 201 Step 1 (Planning) funding was made on a priority basis by Colorado. Priority ranking for projects is made in Colorado by the Executive Branch and is dependent upon existing and potential water quality problems, and severity. The eastern Eagle County study area received a priority ranking of 36 in 1975 and was approved for a FY76 201 Step 1 grant. The study area includes three sanitation districts, the Vail Water and Sanitation District (VWSD), the Upper Eagle Valley Sanitation District (UEVSD), and the Red Cliff Water and Sanitation District (RCWSD).

The geologic location of the study area is the southern Rocky Mountain physiographic province, between the northern end of the Sawatch Mountain Range and the western flank of the Gore Range. The boundaries of the Upper Eagle Valley Sanitation District, and the Vail and Red Cliff Water and Sanitation Districts comprise much of the private land along Gore Creek and the Eagle River. The districts are surrounded by National Forest lands. The

general location of the study area and the boundaries of these districts are shown on the accompanying Figures 1 and 2.

The existing environment within the study area is described in this chapter under the headings of:

- Water Management Goals, Policies and Current Projects
- The Social Environment
- The Biological Environment
- The Physical Environment
- Existing Facilities and Sewage Flows

WATER QUALITY GOALS, POLICIES AND CURRENT PROJECTS

The purposes of this section are to:

- Review and summarize applicable federal, state and local statutes, plans and policies
- Describe current water quality management projects

Water Quality Management Laws, Plans, and Policies

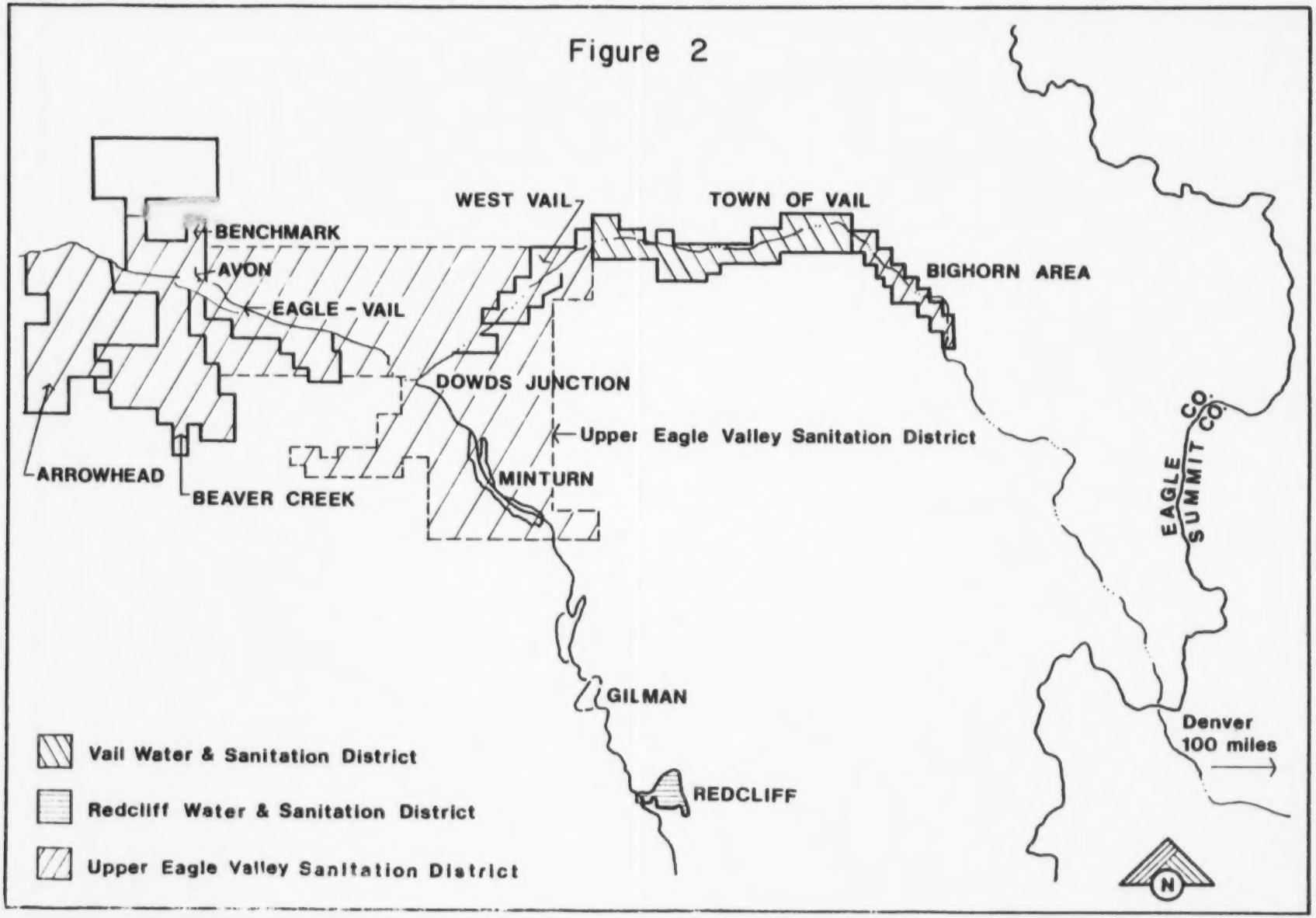
Existing statutes affecting this 201 facilities plan are summarized below:

Federal Water Pollution Control Act Amendments of 1972 -- The primary goals of the Federal Water Pollution Control Act of 1972 (Public Law 92-500) are: by 1983, achieve, wherever possible, water that is clean enough for recreational uses and the protection of fish and wildlife; and, by 1985, completely eliminate the discharge of all pollutants into the nation's waters. The law stipulates a series of steps with strict deadlines and enforcement provisions. The Act is administered by the Environmental Protection Agency (EPA); however, with EPA approval, responsibility for implementation of certain portions has been delegated to state agencies. In Colorado, the Water Quality Control Commission of the Colorado Department of Health (CDOH), acts as the state delegated agency.

The Act authorized federal grants for 75 percent of the planning, design and construction costs of new or improved sewerage facilities. Facilities plans must conform to state planning programs as well as other water quality programs established in other sections of the Act (e.g., Sections 208 and 303(e)).

Reproduced from best available copy.

Figure 2


BENCHMARK
AVON
EAGLE - VAIL
ARROWHEAD
BEAVER CREEK
WEST VAIL
TOWN OF VAIL
BIGHORN AREA
DOWDS JUNCTION
Upper Eagle Valley Sanitation District
MINTURN
GILMAN
REDCLIFF
EAGLE CO.
SUMMIT CO.
Denver
100 miles
N
Vail Water & Sanitation District
Redcliff Water & Sanitation District
Upper Eagle Valley Sanitation District

Section 208 provides for the implementation of areawide waste treatment management planning. Within designated 208 planning areas, 201 facilities plans represent one component of the more comprehensive 208 plan. The study area is within the Eagle-Piney Subbasin, which is within Colorado Planning and Management Region XII, a designated 208 planning area.

Section 303(e) of the Act specifies that each state shall have a continuing planning process for the maintenance of the quality of all waters within its boundaries. This section requires water quality management plans to be prepared for designated entire river basins within a state. A primary purpose is to evaluate present water quality and specify water quality objectives to be achieved in the basin, providing a basis for establishment of waste discharge requirements and wasteload allocations for streams. Another purpose of basin planning is to recommend regional and local planning areas for waste management and facilities planning under Sections 208 and 201 of the Act. The study area is located within the Colorado River Basin, and the 303(e) Basin Plan for this area has been completed. The plan, published by the CDOH, serves as the foundation for regulating all activities which could potentially affect water quality. Wasteload allocations have been established for surface flows in the Eagle-Piney Subbasin.

The Act establishes a system of permits for waste discharges, replacing the Refuse Act permit program of 1899. The National Pollutant Discharge Elimination System (NPDES) is administered by the individual states, with EPA approval. In Colorado, the NPDES program is administered by the Water Quality Control Commission of the CDOH, under the State Water Quality Control Act.

Colorado Water Quality Control Act -- The Colorado Water Quality Control Act (SB 390, 1973) provides a foundation for maintaining control of water quality within Colorado and in carrying out the objectives of the FWPCA. It created the Water Quality Control Division and the Water Quality Control Commission within the CDOH. Duties of the Commission include adoption and revisions of state water quality standards and a revised stream classification system. Waste discharge standards, wasteload allocations and discharge permits are administered by the Division.

In August 1975, the present waste discharge standards were adopted. Stream segments have been classified as either "water quality limited" or "effluent limited." On effluent limited streams, permits are based solely on the state discharge standards. On water quality limited streams, permits are more restrictive since the state water quality standards would not be maintained with only the standard limitations. In these situations, the amount of each

pollutant discharge allowable (wasteload allocation) is determined in basin water quality management plans. (The Commission may also adopt additional discharge standards for pollutants not included in the original standards.)

Colorado has adopted an anti-degradation policy toward the quality of state waters. Waters which presently are superior in quality to the established standards shall be so maintained, where economically feasible. Other federal and state water quality programs are discussed in Appendix A.

Colorado Waste Discharge Standards -- In accordance with PL 92-500, EPA published minimum effluent requirements for secondary treatment, shown in Table 1 on the following page. Individual states may impose more stringent limitations.

In January 1973, under provisions of the Colorado Water Quality Control Act, Colorado adopted effluent discharge standards which were more rigorous than those of EPA, with respect to BOD and SS, and more extensive. The regulations required all treatment plants to be producing effluents with BOD and suspended solids concentrations of 20 mg/l or less by 1978. It was later determined that these standards could not be attained by 1978, due to lack of financial assistance to provide the necessary improvements.

A revised set of effluent discharge standards became effective in August 1975, as shown in Table 2 on the following page. Current discharge permits reflect these requirements, unless more stringent criteria are required to maintain water quality standards of the receiving stream. The Eagle River and Gore Creek are water quality limited streams -- they cannot meet the B_1 classification without more restrictive waste discharge limitations than the minimum recommended above.

Colorado Water Diversion Projects

Table 3, on the second following page, gives a summary of the current water diversion projects which will potentially divert water from the study area. The Homestake Project already diverts water from the Upper Eagle drainage basin and plans are being formulated for additional water exportation. The Eagle Piney/Eagle Colorado Project is another project which may eventually cause the exportation of additional water from this basin. Exports of water are totally consumed in that water is not returned to the stream from which diverted. Due to the fact that wasteload allocations for water quality requirements are based upon stream flows, the potential effects of these projects are presented. A study has been undertaken by the various water and sanitation districts in the area to further evaluate these potential depletions. The proposed projects are illustrated in Figure 3, following Table 3.

The Homestake Project is a joint venture trans-mountain diversion project for the cities of Aurora and Colorado Springs. Phase I,

TABLE 1

EPA MINIMUM EFFLUENT REQUIREMENTS FOR SECONDARY TREATMENT

Parameter	Unit	Value	
		7-day average	30-day average
1. Biochemical oxygen demand (BOD) (five-day)[1]	mg/1	45	30
2. Suspended solids (SS)	mg/1	45	30
3. Fecal coliform[2]	No./100 ml	400-12,000	200-6,000
4. pH		6.0 to 9.0	

NOTES: [1] 85 percent removal is also required; in the case of a dilute influent, this requirement may be more restrictive than the effluent limitation.

[2] Geometric mean; minimum recommended requirements are 400/ml and 200/ml, however, depending upon temperature and streamflow and other critical conditions, the less stringent requirements shown in the table may be imposed.

TABLE 2

COLORADO WASTE DISCHARGE REQUIREMENTS

Parameter	Unit	Value	
		7-day average	30-day average
1. Biochemical oxygen demand (BOD)	mg/1	45	30
2. Suspended solids[1]	mg/1	45	30
3. Fecal coliform[2]	No./100 ml	400-12,000	200-6,000
4. Residual chlorine	mg/1	less than 0.5	
5. pH		6.0 to 9.0	
6. Oil and grease	10 mg/1 and there shall be no visible sheen		

NOTES: [1] 85 percent removal is also required; for a dilute influent, this requirement may be more restrictive than the effluent limitation.

[2] Geometric mean. "Whatever is necessary to protect the public health in the stream classification to which the discharge is made." A scale is used depending on stream class and characteristics.

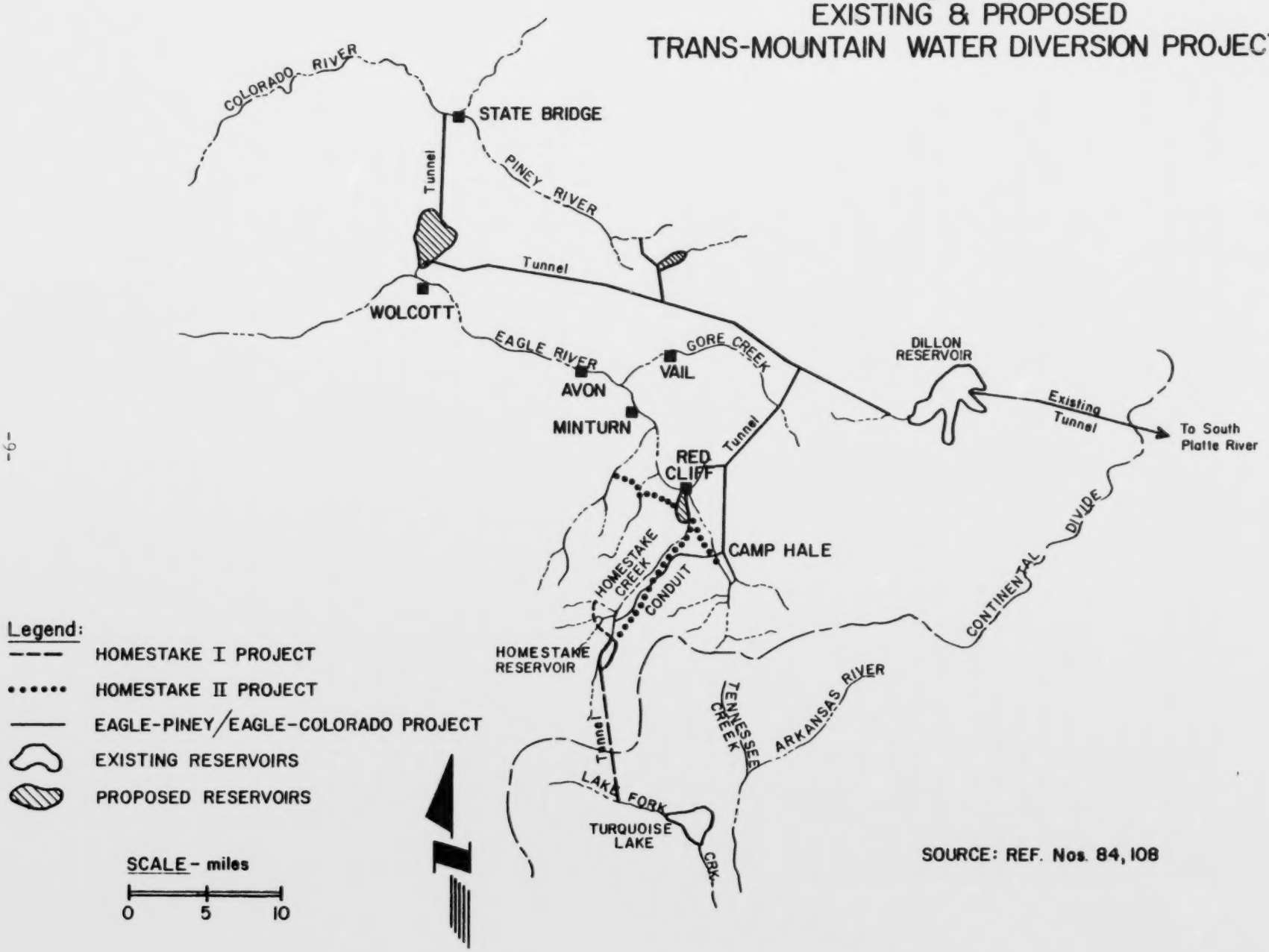
SOURCE: Colorado Department of Health

TABLE 3

PROPOSED WATER DIVERSION PROJECTS
IN THE STUDY AREA

Project Benefactors	Status	Source(s)	Appropriations /Effects
Homestake Water Diversion Project Cities of Aurora Colorado Springs Two Parts - Homestake and Eagle-Arkansas Divisions	Homestake Division Phase I complete/ Homestake Dam & Reservoir (joint undertaking Aurora, Colorado Springs, Colorado River Water Cons. Dist.)	Eagle River tributaries- Fancy, French, Sopris, Missouri Homestake Creeks	USGS predicts annual loss of 34,600 acre feet per year when complete from Homestake Creek Water rights adjudicated in 1962 appropriated in 1952
	Phase II not complete Essentially would be an expansion of the above Includes Iron Mountain Dam below Homestake Reservoir		Phase II would divert up to 31,100 acre feet per year
	Arkansas Division Iron Mountain Reservoir	Upper Eagle River tributaries - Cataract, Piney, Fiddler, Mitchell and East Fork of Eagle River	Potential annual diversion of 8,300 acre feet per year
Eagle-Piney/Eagle Colorado project Denver Water Board	Still in planning stages Stage I - Piney Reservoir and transcreek diversion tunnels Stage II and III - (construction on drainages out of study area) Eagle Colorado Dam	Export from Eagle and Piney River Drainages Bighorn, Pitkin, Booth Middle, Red Sandstone and Black Creeks Piney River	Water rights adjudicated in 1962, appropriated in 1956 Stage I - 35,500 acre ft. per yea Stages I & III None
	Stage IV - diversion facilities on Upper Eagle	Resolution Homestake Turkey Lime & Wearyman Creeks Upper part of Eagle River	Stage IV - 17,900 acre feet per year

Figure 3
EXISTING & PROPOSED TRANS-MOUNTAIN WATER DIVERSION PROJECTS



SOURCE: REF. Nos. 84, 108

the Homestake Division, is complete; Phase II, the Eagle-Arkansas Division is in the planning stage. Phase I, accomplished in 1967, includes the Homestake Dam and Reservoir, on Homestake Creek. Water is transported through Homestake Tunnel to the eastern slope where it is stored in three reservoirs.

USGS records indicate an annual diversion of 34,600 annual acre feet (42.7 cubic meters) from the project. Expansion (Phase II) of the Eagle-Arkansas Division involves construction of the Iron Mountain Dam below Homestake Reservoir. Stored water would be pumped to Homestake Reservoir for distribution. Phase II would divert an additional 31,000 annual acre feet.

The Eagle Piney/Eagle Colorado Project would export water to the Denver metropolitan area through Dillon Reservoir and the Roberts Tunnel Collection System. Construction is envisioned in four stages: Stage 1, Gore Creek and Piney River tributary diversions; Stages II and III would affect drainages outside the study area; Stage IV, diversion and transmission of Upper Eagle River basin drainages. (Stage II would transport water from the Eagle Colorado Reservoir.)

The potential effects of these projects on streamflow in the study area are such that a maximum of 92,000 annual acre feet could be exported upstream from the Cross Creek confluence. In essence, the annual Eagle River yield at Red Cliff could be exported. The annual yield of Gore Creek would be substantially affected by the Eagle Piney/Eagle Colorado Project.

Since wasteload allocations are based upon historical flows, a further reduction would have detrimental effects on the capacity of the streams to support fish life in various reaches. However, the extent to which streamflow would be affected can only be determined if the diversion periods and rates are established for the projects, and these are, to date, unknown. Estimating flow rates at most locations on streams in the study area is not feasible due to the sparse distribution of stream gauging stations and associated records. In addition, diversion periods tend to vary annually, being governed by the seniority of the water rights, the availability and senior demand for water, and other diversion stipulations included in agreements with government agencies. Therefore, the expected effects of water exportation on streamflow cannot be accurately predicted. However, legal controls will probably be invoked to ensure that a desired level of streamflow is maintained.

The water rights of both projects are relatively junior, due to their late adjudication dates. Consequently, these projects present no probable harm to most other appropriators. Most diversions made under junior rights, such as the Homestake I diversions, usually must be made and stored during the heavy runoff period occurring with spring snowmelt. The Homestake I project, in agreement with the Bureau of Land Management, is allowed to divert only during the months of April through August. Provisions for insuring flows through priority rights and statutes are discussed further in the mitigations section.

THE SOCIAL ENVIRONMENT

Population and Population Projections

Population and Land Use -- The existing populations within the study area comprise the major population centers of eastern Eagle County and 65 percent of the total countywide population. The following table summarizes current estimated population distribution. The location of the population centers named in the table was shown in Figure 2 on page 4.

TABLE 4

1975 ESTIMATED EASTERN EAGLE COUNTY PERMANENT POPULATION[1]

Population Centers	Population
Vail[2] (east and west)	4,000
Minturn Valley	1,500
Red Cliff	700
Gilman	350
Unincorporated area (Avon, Beaver Creek and Eagle-Vail)	650
TOTAL	7,200

NOTES: [1]Permanent population for the purpose of this report is defined as permanent residents who live in the area for at least a season (winter - 5 months, summer - 7 months)

[2]The average of both summer and winter projections, 4,000, is utilized to estimate year-round population. Vail has high variances in summer vs. winter permanent population due to job seasonality. Summer population is estimated as 70 per cent of winter population. Minturn and the Avon area experience some fluctuation which is small by comparison. Although permanent population levels are relatively low, the area has a large visitor population.

The existing populations, both permanent and visitor, are predominantly recreation-oriented. The Vail ski area, established in 1963, has influenced the study area growth and has produced the major population fluctuations. Average winter visitor population is 9,700 persons; average summer visitor population is 3,000 persons.

Within eastern Eagle County most jobs are associated with the recreation influence of Vail. Over 80 percent of the total jobs are in the transportation, construction trade, services and public administration sectors. Agriculture and mining employ three and eight percent, respectively; finance, insurance and real estate accounted for eight percent during the 12-month period, 1974. The fluctuation in employment and unemployment is seasonal. In 1974, the summer (May-Nov.) employment was 82.5 percent of the winter. Unemployment levels in the County rose from 4.0 percent to 4.5 percent between the winter and spring quarters.

Eastern Eagle County has developed from a ranching and agricultural area to an essentially recreation-oriented area. Land use has been influenced by ski area development since 1963, and much of the agricultural land has been taken out of production. Access is provided by Interstate 70 (I-70), an east-west interstate highway system. One segment of I-70 will soon be completed over Vail Pass, to the west of the study area.

East Vail, from the eastern boundary of Vail at the foot of Vail Pass to the golf course, is a low-density, residential area of single and multi-family dwelling units. This area experiences severe climatic conditions, and steep slopes place some of this area in avalanche paths. It is not an area of high development pressure.

Between the golf course and Vail Village there are a few single family residences and a few high density condominium developments near the west end of the course. This area is recreation/open space in character.

Vail Village and Lionshead are the two commercial centers. The Village is older, and more densely developed, with many multi-family units (condominiums) mixed with lodge units (both rental condo and motel type), and commercial businesses, restaurants and shops. Lionshead is connected to the Village by pedestrian ways, bicycle paths and a mini-bus system. Vail is pedestrian-oriented; cars are restricted from the centers, with the majority of parking provided along the fringes.

Separated from Vail proper by the Interstate system (I-70) is the strip development, which continues north and south of I-70 from Lionshead west. This area contains condo-lodge type development for approximately a mile, then the south face of the mountain drops back, and an area known as West Vail opens to

single family dwellings interspersed with multi-family units. Parts of West Vail have been annexed, most recently the Lionsridge and Sandstone development areas.

The Interstate from West Vail to Dowds Junction winds through a steep canyon, limiting the area's use, and no development occurs until the junction is reached. Sprawling, single-family residential development and trailers are characteristic of the Minturn Valley. The community of Minturn has an old commercial center, where development begins close to the stream bed and continues on the southwest slopes. Minturn developed in a linear pattern paralleling the Eagle River and Highway 24 which bisect the town. The Denver and Rio Grande property north of town was annexed in 1974. An estimated 50 percent of the properties in Minturn are rental, and 34 percent of the total are listed in poor condition. Light industries include a concrete company, a lumber yard and a batch plant.

Red Cliff, a small community south of Minturn, houses mostly New Jersey Zinc Corporation employees. Most residences are single family or duplex. Less than 200 residences are found in Red Cliff.

Between Dowds Junction and Avon, the Upper Eagle Valley opens to uncultivated agricultural lands, which are subdivided. The Eagle-Vail subdivision has several single and multi-unit buildings, tennis courts and a golf course. The Benchmark development has completed a shopping center. Some employee apartments have also been completed which are part of the overall development plan. Beaver Creek, the third subdivision including a major ski area had not begun development as of the Winter of 1976. Beaver Creek has secured the necessary Forest Service permits for the ski area, considered to be the necessary economic determinant to ensure the success of all three subdivisions as planned. Currently a general store/post office/gas station and mobile home park development exist in Avon.

Arrowhead, adjacent to Beaver Creek, is a second planned ski area development, on private rather than public land. Two golf courses, tennis and equestrian trails are part of the overall plan. Area realtors project that Beaver Creek will be developed more rapidly than Arrowhead.

Population and Land Use Projections -- Future population and land use projections were developed for the 201 planning effort. The accomplishment of these projections was based upon: public acceptability, local knowledge, acceptance by local planning and government officials and the adaptability for use in other planning efforts. One constraint in developing 201 projections was the on-going effort to accomplish 208 planning. As part of a

large, six county 208 study, Eagle County projections for both efforts had to be prepared concurrently. The Eagle County Planning Office (ECPO) had the responsibility for the preparation of the 208 projections. Because the 201 planning effort and schedule would have been delayed without the necessary future service area/needs projections, EPA authorized the 201 effort to proceed ahead of the 208 planners with the stipulation that the figures be adopted by the 208 planning staff of the ECPO.

Development of the 201 projections included a number of interviews and thus much local knowledge as to historic growth in Vail and current planning efforts was obtained. Also various ratios (e.g. number of visitors to available accommodations), and other available population projections were used. Future trends were developed based upon the assumptions (population influencing factors) given in Table 5 on the following pages. The methods and definitions are explained in depth in Appendix B.

The assumptions resulted in three profiles for development, which have been labeled high, medium, and low. The results of these profiles and projections are given in Table 6 following Table 5.

The projections were presented in the spring, 1976, to the 201 Advisory Board and the UEVSD and Vail Sanitation District Boards, the Eagle County Planning Commission (ECPC) and the public. The ECPC adopted the high figures for Beaver Creek, the moderate for Vail and Arrowhead, and the low for Minturn, now referred to as the 201 adopted projections. In the fall, 1976, the ECPO revised the projections to reflect new data and input from the 208 planning effort, such as a Vail housing survey. The results, compared in Table 7, following Table 6, reflect, in brief:

- Eastern Eagle County population is expected to more than double by 1995
- Most of the new population is expected to locate in the Avon/Beaver Creek/Arrowhead area
- The magnitudes of growth in both the 201 and 208 projections agree in 1985 and are within four percent in 1995
- The location of growth in the 201 and 208 varies in that ECPO placed more population, 2,000, in Vail, and placed some of the Beaver Creek allocation in Arrowhead. (Neither of these two factors substantially affects the planning for sewerage facilities).

Within the Gore Valley virtually all of the developable land has been either platted or zoned. Zoning now exists for more than double the number of present units. Due to recent

TABLE 5

COMPARATIVE ASSUMPTIONS UTILIZED

FOR

THE POPULATION PROJECTIONS

LOW GROWTH PROFILE

BASIC CONDITIONS FAVORABLE OR UNFAVORABLE TO THE OVERALL AREA DEVELOPMENT	Completion of I-70 and the Second Bore of tunnel. Competition from other areas in both other counties (day skiers) and other states (destination skiers). Continued unfavorable tax breaks on second homes. Aggressive growth management by the town of Vail. New ski area development is delayed.
GORE VALLEY Vail and West Vail (including Bighorn)	Expansion of mountain capacity to 11,000 (14,000 peak) peak not reached before 1985 Downzoning of all new developments, town cores (Vail-Lionshead) do not receive higher density zoning. Moderate growth of West Vail - the condominium market absorption rate for Vail area affected by Beaver Creek, slowing to 100 new units per year until 1985, 100-150 units per year till 1995. Little development in Bighorn Area.
AVON/BEAVER CREEK (Benchmark, Beaver Creek and Eagle-Vail with some fringe growth)	Start Date of development, spring 1980 or 1981; Competition from other areas affects rate of growth, and "total" development is reached in 1995. Future reduction in the total units for the 3 developments occurs. 3000 units are built by 1990 (and 4500 units by 1995). (Ski visitor and summer visitor growth continue to expand in Colorado in this profile and the moderate/high profiles.) For low growth, the expansion is moderate. Skier capacity is 7500-peak 9,000.
ARROWHEAD SKI AREA (Development located west of Beaver Creek)	Under a low growth profile for the Arrowhead ski area the project would be unsuccessful in obtaining financing and development is not begun during the planning period.
MINTURN	Minturn accommodates 10 percent of new recreational employment and their families, under low growth for each area.
RED CLIFF	New Jersey Zinc Corporation either reduces drastically or closes operations in Gypsum.

Table 5 continued

MODERATE GROWTH PROFILE

BASIC CONDITIONS FAVORABLE OR UNFAVORABLE TO THE OVERALL AREA DEVELOPMENT	Completion of I-70 and tunnel. Competition for destination skiers in other states does not affect Colorado skier market drastically, although overall skier visitor growth is not comparable to Vail growth to date (which is now at 18 percent per year average). The summer visitor market expands. Continued unfavorable tax breaks on second homes spurs the development of more lodge units. No delay for new ski area development, although financing may be difficult to obtain.
GORE VALLEY Vail and West Vail (including Bighorn)	Expansion of mountain capacity to 11,000 (14,000 peak). The peak is reached (15 days per season) in 1982. (Marketing of off peak weekdays and differential pricing may occur to lessen peaks.) Peak Day skier demand totals exceed the combined areas; capacities by 1990 necessitating Forest Service and Ski Developer cooperation in limiting ticket sales and finding solutions. Downzoning of all new developments occurs. Town core areas are granted higher densities based upon demonstrated economic need. Growth takes place in West Vail, the market absorption rate for Vail area expands in 1983, in 10 years 1000 new units are sold and between 1990-1995, 500 new units. A lodge and few units are built in Bighorn.
AVON/BEAVER CREEK (Benchmark, Beaver Creek and Eagle-Vail with some fringe growth)	Start date of development, Spring 1978. Total development is reached in 1995, however, due to future downzoning the total is reduced from 7180 to 5500-6000 units (market absorption rates could also affect this reduction). By 1990 4,400 units are built, and by 1995 new units total 6000. (The market for lodge units will affect the condominium mix and therefore more high occupancy units could be build.) The moderate profile projects as many total units in Beaver Creek/Avon in 13 years as Vail has today after 13 years of growth, supporting a smaller mountain. The skier capacity of 7500 (9,000 peak) is reached in 1993-94 and after that year the Forest Service could allow expansion or require the limitation of ticket sales.
ARROWHEAD SKI AREA (Development located west of Beaver Creek)	Start date of development, 1982-83. Competition from other areas affects the rate of growth, however, 60 percent of the total planned Arrowhead development is reached by 1995. Future downzoning is projected to occur and total estimated units allowed, 2000, would not all be built until beyond the study period. Total skier capacity, 4800 (6000 peak). Arrowhead's share of the condominium market is approximately 25 percent, if current trends continue.
MINTURN	Minturn attracts 10 percent of recreation related new population under moderate growth for the area.
RED CLIFF	No moderate assumptions were made.

Table 5 continued

HIGH GROWTH PROFILE

BASIC CONDITIONS FAVORABLE OR UNFAVORABLE TO THE OVERALL AREA DEVELOPMENT	Completion of I-70 and tunnel. Skier visitor and summer recreation industry expand, and the market is favorable for the rapid growth of new ski area development. The second home market is not affected by fewer tax breaks, the overall economy makes gains and the expanded influx of outside U.S. investments to the Vail area all promote development.
CORE VALLEY Vail and West Vail (including Bighorn)	Expansion of mountain capacity to 14,000 peak (peak reached in 1983) (marketing could "even out" the peaks) however, the Forest Service and ski developers must limit sales on weekends and seek alternative solutions. Less downzoning of new development than the present trend of 50 percent. Town core areas receive higher density zoning. Much of the new growth takes place in West Vail. Market absorption rate continues to be between 200-300 new units per year (could be higher, if not for the competition from new ski areas). A lodge and condo units are built in Bighorn. In total, 3000 new units are sold from 1976-1990 and 900 more between 1990-1995. Also some new low rent (employee) units are built.
AVON/BEAVER CREEK (Benchmark, Beaver Creek and Eagle-Vail with some fringe growth)	Although Avon area developers project build-out to 7180 units by 1990, neither current trends, Vail historical growth or the ski industry projections support such astronomical growth. In the high growth profile, total development could be reached in 1995 if the Vail growth rates were duplicated (Vail was built during more favorable economic conditions) and if either the mountain capacity was expanded or if low occupancies in new units were realized. By 1990, 5500 units are built and by 1995, 7000 units. At this time, peak day skier demand could be as high as 12,900 skiers even if many units were low occupancy, private condos, and higher if the high to low occupancy ratios were split 50/50 as in Vail today. Peak skier capacity in Beaver Creek (9000) begins to be exceeded by 1991.
ARROWHEAD SKI AREA (Development located west of Beaver Creek)	Development begins in 1979 and attains 90 percent of full developer projections by 1995, or 2970 units. The rate of development is accelerated as at Beaver Creek; although these two areas are in competition and one area's capture of the market may affect another's share. By 1990 over 2000 units are built. If added to the Beaver Creek unit, 8000 total units are built, and if added to Vail 11,000 units. Market absorption rates under high profiles for all 3 areas, are 800-900 units per year, double the rate of growth at Vail during the initial time period.
MINTURN	Minturn attracts 10 percent of all new permanent population and much of the transient construction force.
RED CLIFF	The Iron Mountain Dam is built, and many construction workers move to Red Cliff. The mine continues operation, perhaps opening a new vein of zinc.

TABLE 6

POPULATION PROJECTIONS FOR THE

GORE AND UPPER EAGLE VALLEY

LOW PROFILE ASSUMPTIONS

	Population Estimates				
	1975	1980	1985	1990	1995
Gore Valley					
Permanent Population	4,750	4,800	4,880	4,940	4,980
Average Daily	13,250	16,400	17,350	18,700	19,200
Peak Day	20,250	22,700	23,200	24,300	24,900
Avon/Beaver Creek					
Permanent Population	600	1,800	1,300	2,330	3,200
Average Daily	600	1,800	3,700	8,200	11,500
Peak Day			4,000	9,900	14,400
Arrowhead					
Minturn Valley	1,500	1,750	1,770	1,750	2,000
Redcliff	650	600	420	400	380
Totals (Average Daily)	16,000	20,550	23,240	29,050	33,080

MODERATE PROFILE ASSUMPTIONS

	Population Estimates				
	1975	1980	1985	1990	1995
Gore Valley					
Permanent Population	4,750	4,800	5,160	5,430	5,660
Average Daily	13,250	16,400	19,000	19,580	21,230
Peak Day	20,250	22,700	24,700	26,500	27,300
Avon/Beaver Creek					
Permanent Population	600	1,300	2,000	2,900	4,200
Average Daily	600	3,900	6,400	10,000	15,000
Peak Day		4,800	9,300	12,700	18,500
Arrowhead					
Permanent Population			300	600	975
Average Daily			1,860	3,770	5,595
Peak Day			2,260	4,320	6,340
Minturn Valley	1,500	1,880	1,955	1,920	2,150
Redcliff	650	700	1,200	1,200	750
Totals (Average Daily)	16,000	22,900	30,400	36,500	44,700

HIGH PROFILE ASSUMPTIONS

	Population Estimates				
	1975	1980	1985	1990	1995
Gore Valley					
Permanent Population	4,750	5,000	5,520	6,020	6,440
Average Daily	13,250	17,600	20,500	22,500	24,170
Peak Daily	20,250	23,060	25,160	27,520	31,800
Avon/Beaver Creek					
Permanent Population	600	1,200	2,900	3,900	4,900
Average Daily	600	4,000	9,700	13,900	18,200
Peak Daily		5,000	12,200	16,700	22,800
Arrowhead					
Permanent Population		280	650	1,280	1,780
Average Daily		1,520	2,960	4,500	8,300
Peak Daily		2,030	3,950	6,800	10,500
Minturn	1,580	1,930	2,030	2,190	2,400
Redcliff	650	700	1,200	1,200	750
Totals (Average Daily)	16,000	25,750	36,600	44,300	53,800

The population projections included estimates of: permanent population, based upon an estimated number of new jobs in the area and the associated population; average daily visitor population, based upon accommodations and occupancy; skier demand, based upon historic skier to visitor ratios and peak population (winter) based upon historic visitor occupancy peaks and permanent population. For specific details, refer to Appendix X.

SOURCE: Camp Dresser & McKee Inc.

TABLE 7

COMPARISON OF ADOPTED 201 POPULATION PROJECTIONS
AND THE OCTOBER 1976 EAGLE COUNTY POPULATION PROJECTIONS

LOCATION	1975 ECPO	1975 201 Adopted	1980 ECPO	1980 201 Adopted	1985 ECPO	1985 201 Adopted	1990 ECPO	1990 201 Adopted	1995 ECPO	1995 201 Adopted
Vail/Gore Valley										
Permanent	4,750	4,750	4,800	4,800	5,160	5,160	5,430	5,430	5,660	5,660
Average Daily	16,820	13,250	18,370	16,400	19,920	19,000	21,460	19,580	23,120	21,230
Peak Day		20,250		22,700		24,700		26,500		27,300
Avon/Beaver Creek										
Permanent	560	600	1,200	1,200	2,900	2,900	3,900	3,900	4,900	4,900
Average Daily			5,000	4,000	8,000	9.700	11,500	13,900	15,130	18,200
Peak Day				5,000		12,200		16,700		22,800
Arrowhead										
Permanent	4		280		650	300	1,280	600	1,900	980
Average Daily			2,030		3,550	1,860	6,000	3,770	8,750	5,600
Peak Day						2,260		4,320		6,340
Minturn	1,227	1,500	1,880	1,880	1,960	1,960	2,050	2,050	2,150	2,150
Red Cliff	537	650	600	600	420	420	400	400	380	380
Totals:										
Permanent	7,078	7,500	8,760	8,480	11,090	10,740	13,060	12,380	14,990	14,070
Average Daily	19,150	16,000	27,880	22,880	33,850	33,140	41,410	39,700	49,530	47,560

Notes: 1. All numbers rounded to nearest 10.
2. Average daily population is winter only and includes visitor population.
3. Summer population averages are 30-60 per cent less than winter averages, due to the number of visitors.
4. The 201 adopted figures are similar to those of Eagle County revised in October of 1976 with the following observations:
- The County Planning Office has allocated more population to Arrowhead and less to Beaver Creek (the developments are adjacent).
- The County has projected Vail permanent population to be higher in all years.

Sources: Eagle County Planning Office (ECPO); Camp Dresser & McKee 201 Population Analysis

planning efforts by the town of Vail:

- Significant downzoning of recently annexed areas has been accomplished through compromises with developers
- A growth management effort is being pursued

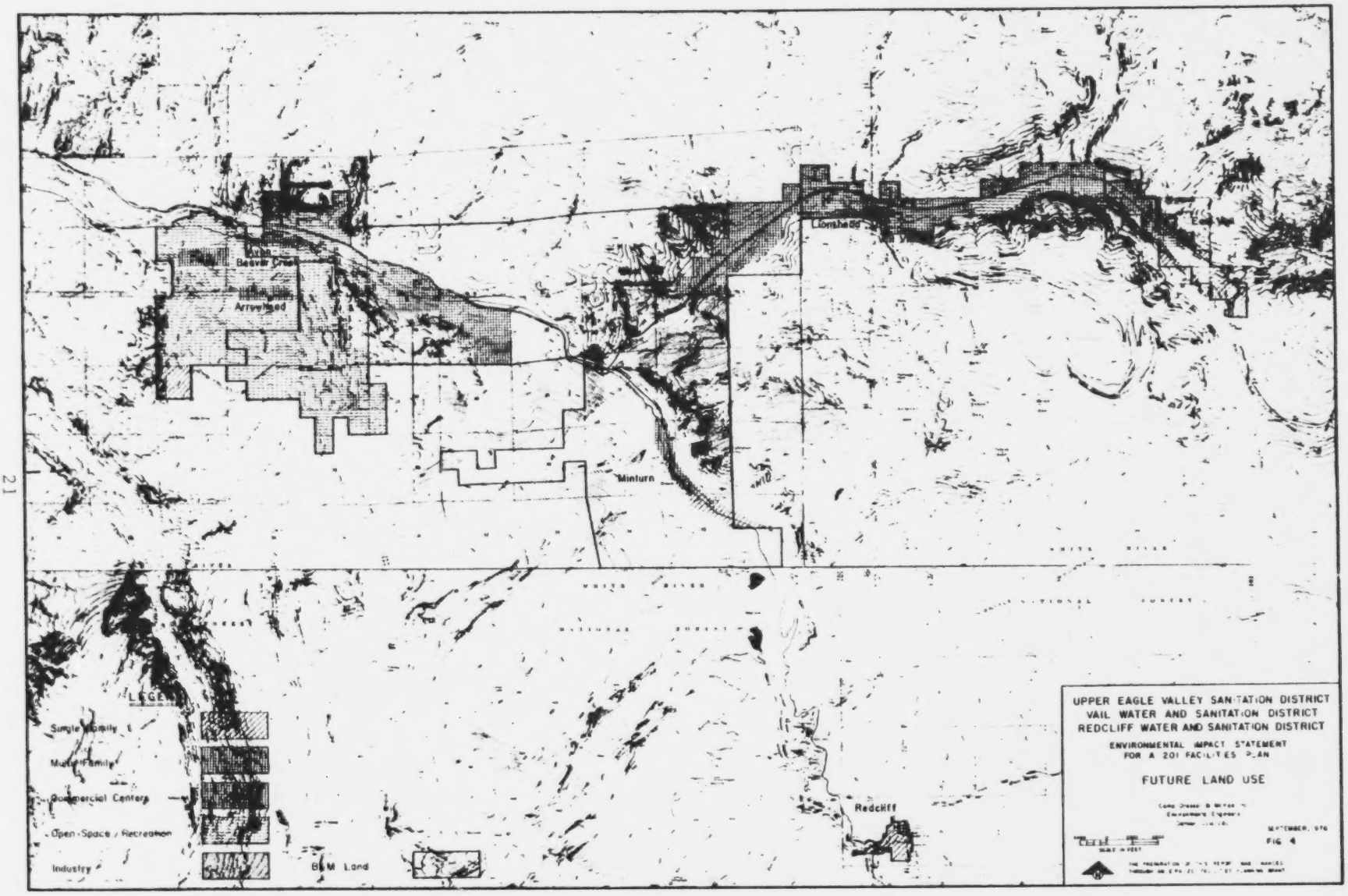
The projections of future land use in the Gore Valley were based upon these efforts. In addition, continued low market absorption rates with the advent of Beaver Creek would mean a lessening of growth in the Vail area. A total of 2,800 new units are projected to be built between 1976 and 1995. Future development in Vail Village is expected to be contained, with an infilling of present commercial areas. West Vail will receive the strongest development pressures, and Bighorn will receive less development pressure than the other areas. Future generalized land use patterns are shown on Figure 4, on the following page. Present and future land uses by percentages are given in Figure 5, following Figure 4.

The Upper Eagle Valley area at Avon/Beaver Creek/Arrowhead is projected to grow rapidly within the study period. The Beaver Creek ski area will probably reach full development within each of the subdivisions, a total of 7,100 units in 20 years. Significant fringe area development was not projected due to the assumed balance within market competition. If fringe areas develop, they may tend to slow down the period of full development projected for other subdivisions. The Arrowhead ski area development which is evaluated as more speculative, is expected to build 1600 units during the next 20 years.

Within the Arrowhead and Beaver Creek ski areas, golf courses, equestrian trails and park areas will provide both summer and winter recreational opportunities. Regional shopping center facilities will be provided at Benchmark and industrial sites at Eagle-Vail. Future land uses and development patterns are given in Figures 4 and 5.

The largest developable area outside current planned development boundaries is the Nottingham Ranch property which is adjacent to Eagle-Vail across Interstate 70. A second developable area is the corridor between Arrowhead and Squaw Creek. These two areas are outside the sanitation districts' boundaries.

Minturn will grow due to its ability to provide less expensive housing alternatives for the resort area employees. Growth pressures will be lessened somewhat by the commitment of the promoters of the Beaver Creek and Arrowhead developments to provide on-site employee housing. Between 300-400 units are projected to be built in Minturn during the 20 year period, nearly double



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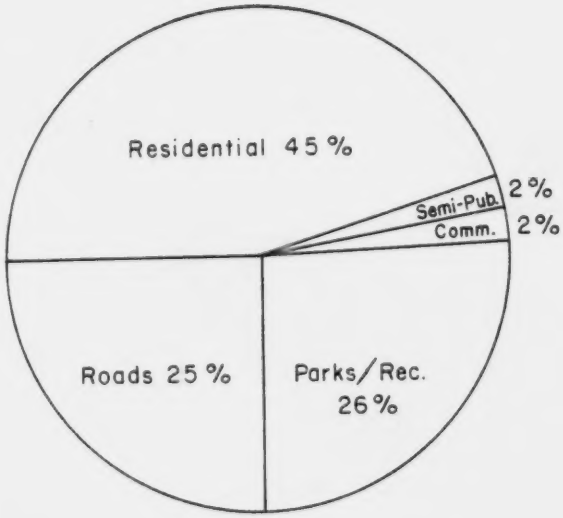
Present & Projected Percentage of Land Use

GORE VALLEY



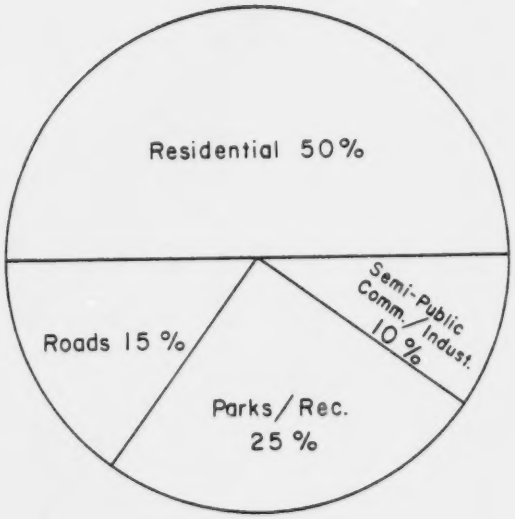
2940 acres, present

3300 acres, projected

(Open space & agricultural not included.)

Projected Percentage of Land Use

AVON/BEAVER CREEK/ ARROWHEAD



3430 acres

(Open space/recreational- ski areas not included.)

SOURCE: Eagle County Planning Office and Developer Estimates

FIGURE 5

the present number. The location of these new units recommended in the Comprehensive Plan is within the incorporated town limits. Minturn's land use pattern is expected to become more intense with potential industrial location on the recently annexed railroad property. Red Cliff is not expected to change due to its relative remoteness and company town character.

Land Use Policies, Plans and Controls

Most of the land within the study area is privately owned. The major exception is the Beaver Creek Ski Area which will be developed partially within National Forest boundaries. It is planned that this development will utilize the facilities of the Upper Eagle Valley Sanitation District, and, accordingly, the controls placed on its use will have a direct impact on the study area. Also, the Bureau of Land Management (BLM) manages several small parcels in the study area. A land exchange is being contemplated between the BLM and the owners of the Benchmark property, since the northern portion of the Benchmark property, outside of the study area, is within an animal migration route. In addition to these Federal agencies, local and state agency plans and policies will influence land use.

Federal Land Use Plans -- The Forest Service operates under the Multiple Use - Sustained Yield Act of 1960 which provides for the use of national forests for outdoor recreation, range, timber, watershed, and wildlife and fishing purposes. Multiple use management allows for special use permits which are a part of overall Multiple Use Plans for every Planning and Management Unit. The Meadow Mountain Planning Unit is composed of four Management units, Grouse Creek, Holy Cross, McCoy and Beaver Creek. Vail has a special use permit in the Upper Eagle Planning Unit and the ski area is itself a management unit, the Vail Mountain management unit. Ski lifts, trails and restaurant facilities are permitted on the public land; base facilities and accommodations are on private land. The Beaver Creek unit was designated as a winter recreation sports site and granted a special use permit similar to that of Vail. The Forest Service reserves the right to (1) limit skier capacity and (2) develop measures to limit the number of lift tickets sold. The District Ranger is responsible for supervision of project construction and for ensuring that implementation takes place as specified in the special use permit.

Parts of the McCoy and Grouse Creek units have been designated as roadless areas. Other parts are set aside for spring and fall habitat, as migration routes for wildlife and for dispersed recreational opportunities, such as hiking, hunting and cross-country skiing.

The BLM also provides for multiple use management. BLM land in the study area is managed for such uses as livestock grazing, recreation, open space and wildlife. The small sections of BLM land within and near the study area are shown in Figure 11 .

Local Government Land Use Controls -- Eagle County reviews plans for all subdivisions and developments. The County Planning Commission has adopted a land use master plan which includes future development patterns and growth policies, goals and objectives. The County plan contains a policy statement expressing the intent to preserve the open, rural character of the County while locating new high-density residential growth in existing and planned centers. The development of new commercial centers at West Vail, Avon/ Beaver Creek and Eagle-Vail have been approved and designated in the County plan.

Sketch plans and preliminary plans were reviewed and accepted and zone district maps amended for all three subdivisions in the early 1970's. Final plat plan acceptance by Eagle County has been obtained by Eagle-Vail and Benchmark, and Beaver Creek is expected to file in the winter-spring of 1977.

Vail and Minturn have local zoning ordinances. In addition, Vail has a Design Review Board which has instituted strict architectural controls. Currently the planning staff and their consultants are developing a growth management plan, which will probably become a guideline for overall development and final plat approvals. The plan may enable the Town to establish a method of evaluating both the economic need and the economic impact of zoning changes, both for admitting higher, and for requesting lower, densities.

The current trend is to contain growth and to down-zone where feasible to minimize growth beyond desirable accommodation/visitor to mountain capacity ratios.

The town of Minturn has a master plan and zoning controls. The plan recommends the continuation of a single family residential orientation; however, Minturn's proximity to the resort areas will continue to bring development pressure for lower-income employee multi-family housing.

State Controls -- The state of Colorado has very limited control over land use, primarily limited to offering coordination assistance for administering planning programs among local governments through the Department of Local Affairs. In fact, the Colorado Land Use Act states that the decision making authority as to the character and use of land shall be made at the lowest possible level of government.

Archaeology, Paleontology and Historic Sites

The area from Vail to Wolcott was examined in terms of:

- Existing archaeologic survey work
- Historic sites which are either presently on the National Register of Historic Sites, proposed, or potentially eligible for the Register.

The Office of the State Archaeologist examined the files which would contain all archaeologic sites recorded for the area. None of the archaeologic sites registered were within the existing facilities sites or the existing interceptor line routes. However, it should be emphasized that the Colorado Archaeological Survey Site Inventory contains only recorded archaeological sites, hence previously unrecorded--and possibly significant--sites could well be present.

The National Register contained one registered historic site, the Wolcott Stage Station, which is west of the study area in Wolcott. No other nominated sites were found in the Federal Register which publishes new and proposed sites every Tuesday. The State knows of no potential sites in the area.

Recreational Facilities

Although the project impact area is a major destination resort center with extensive ski, golf and tennis facilities throughout the area, there are shortages of those facilities found in more conventional residential communities such as parks, playgrounds, and walkways outside of the developed town centers. On the other hand, there is nearby access to public lands for hiking, camping, horseback riding, fishing, and hunting. Within the direct project area, there are no developed recreational facilities, except for two areas of public access to fishing.

Air Quality

An investigation of present air quality in the study area and that which could occur in the future, given the projected population increases, was conducted. The basis for this evaluation was the need to determine, to the extent possible, the potential for future air quality maintenance problems.

Historical, meteorological and air quality data were obtained from local sources. A box model was developed and used to project future pollution from particulates.

Meteorology -- Meteorology or climate conditions may be examined on a regional (macroscale) and local (microscale) level. Regional characteristics include: a prevailing westerly wind which is generally upslope, higher wind speeds in winter than in summer, and frequent large-scale stagnations when the western slope is dominated by high pressure systems.

Microscale meteorological conditions are important in determining local air quality and conditions for the study area. The characteristics of wind speed, wind direction and mixing depth determine air pollution levels in the valleys of the study area. These characteristics are discussed in Table 8, below. The meteorological patterns recorded in Vail were characteristic of mountain valleys -- upslope and downslope winds are recorded within a 24-hour period and air temperature inversions are frequent. As a consequence of these conditions, air pollutants are often trapped inside the valleys when the temperature inversion lowers the mixing depth. Winter temperatures are more often the cause of inversions than summer temperatures. In the study area, inversions usually form at night and persist into the morning. Strong inversions during regional air stagnations, occurring with a lack of wind and solar radiation to break or disperse the inversion, cause a severe curtailment of dispersion.

TABLE 8

METEOROLOGICAL VARIABLES AFFECTING AIR QUALITY

Variable	Characteristic(s)	Effects
Wind Direction	Upslope/Downslope winds-Solar radiation heats air during the day, causing upward (upslope) air flow. Nightime radiative cooling causes downward(downslope) air flow. Reversal in wind directions can be abrupt. Particularly apparent when regional air mass movement is weak (sometimes called diurnal variation).	Upslope/downslope winds dominate the valley except during periods when regional air mass movements dominate valley climate. Strong downslopes can push pollutants into the valley. Upslopes can clear the valley by carrying pollutants out of the valley (confined) area.
Wind Speed	High pressure systems can cause wind stagnation. Low pressure increases wind speed.	Stagnation causes air to be motionless, limiting dispersion and increasing pollution. Increased wind speed facilitates dispersion.
Mixing Depth (or Height)	Defined as distance above which little dispersion of pollutants occurs. When the mixing height is low, dispersion is limited to the lower portion of the atmosphere.	Normal mixing height is unlimited, except during an inversion, when it becomes limited, resulting in high concentrations of pollutants.
Air Temperature	Cooling/Heating-Nightime radiative cooling, daytime solar radiation heating	Cool, nightime air sinks to bottom of valley, trapping polluted air. Warm daytime air rises, allowing pollutant dispersal.

Present and Historic Air Quality -- In the study area, long, cold winters result in extensive fireplace and fuel use which cause high concentrations of pollutant emissions. The valley configuration of the area and the associated meteorology frequently create poor conditions for pollutant dispersion. Thus pollutants become "trapped" in the populated valleys. Poor dispersion conditions and peak emissions tend to occur simultaneously in winter.

Measurements of existing air quality in Vail have shown that total suspended particulate concentrations have either approached or exceeded state and federal standards since 1973. The standards and monitored pollutants are given in Tables 9 and 10 on the following page.

The state 24-hour particulate standard was exceeded on eight days in 1973, five days in 1974, two days in 1975 (at two locations), and in 1976 (one location). IN 1973 the federal 24-hour particulate standard was exceeded once, which is allowable, and it was approached in all years. The state short-term and long-term particulate standards are being exceeded but are within allowable federal limits for both the short- and long-term standards. The locations of the sampling devices were the Vail Valley Medical Center, Vail Associates Maintenance Building, and the clubhouse at the golf course.

Only one year of data was available for carbon monoxide (CO) emissions measurements. In the winter 1975-1976, CO data was collected on a continuous basis by a non-dispersive infrared analyzer located at the Town of Vail Municipal Building. In 1975 the state and federal 8-hour standards, shown in Table 9, were met on a single day, December 30, which is permissible. The graph of emissions measurements for this day is shown in Figure 6 on the second following page.

An Air Quality Model -- In order to calculate particulate concentrations and project them to future years, a mathematical model which approximates the physical situation in the study area during an air pollution episode was used. An episode is a period when climatic conditions remain stable and are not conducive to dispersion. The model used was a multiple box model, a modification of one developed by Marlatt, Holben and Renne in 1973. A total of nine airsheds were identified whose box-like dimensions were

TABLE 9

FEDERAL AND STATE PRIMARY AMBIENT AIR QUALITY STANDARDS

POLLUTANT	FEDERAL STANDARD	STATE STANDARD
Total Suspended Particulates	Micrograms per cubic meter	
Annual geometric mean	75	
Annual arithmetic mean		45
24-hour average[1]	260	150
Carbon Monoxide	Parts per million	
8-hour average[1]	9	9
1-hour average[1]	35	35

NOTES:

1. Not to be exceeded more than once per year

Source: Section 109, National Ambient Air Quality Standards, 1970

TABLE 10

ANNUAL MEAN, TOTAL SUSPENDED PARTICULATES IN VAIL VILLAGE

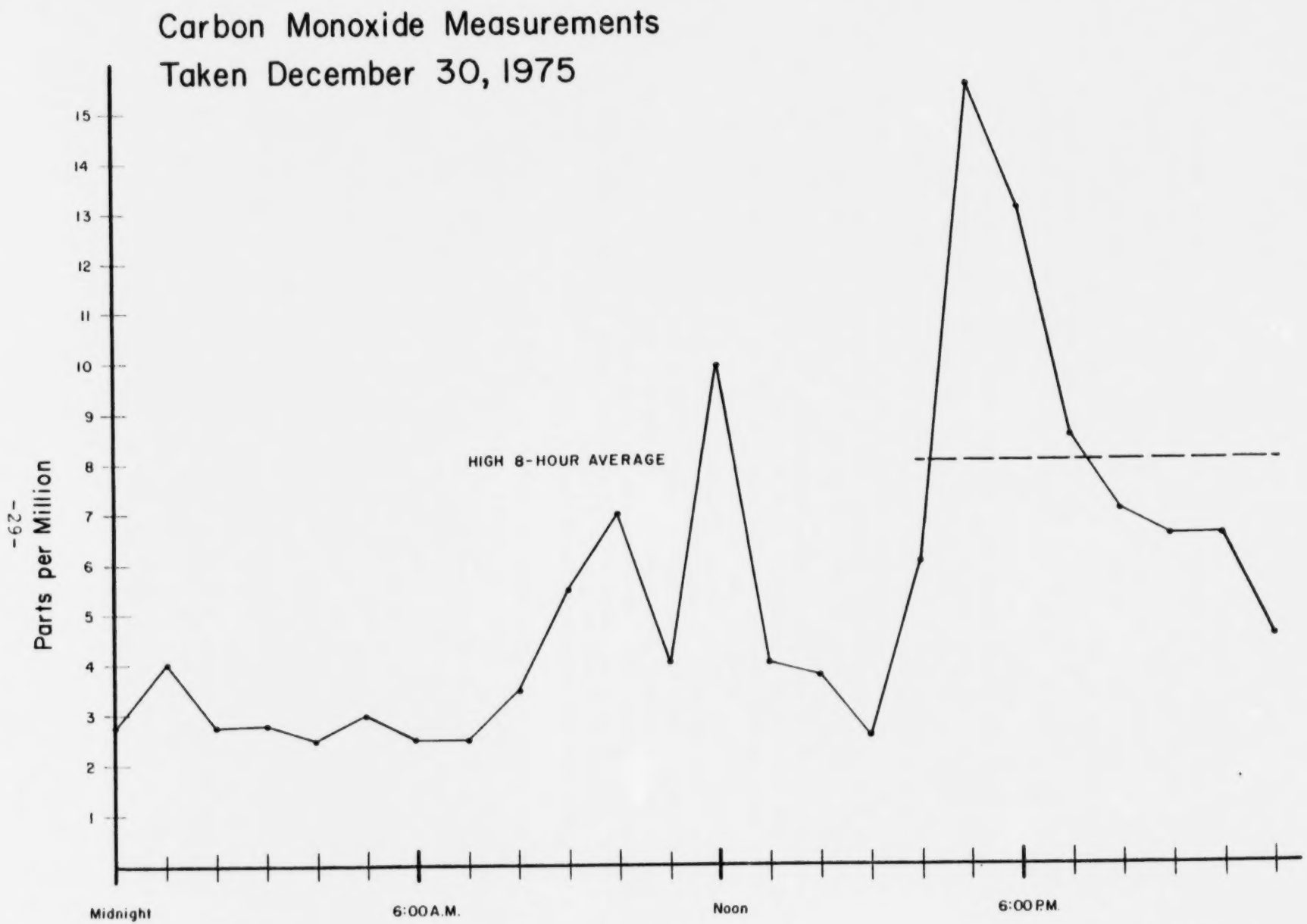
YEAR	GEOMETRIC	ARITHMETIC
	Micrograms per cubic meter	
1973[1]	55	71
1974	59	74
1975[2]	48	61

NOTES:

1. Measured with a high volume sampler filtering device taken for 24-hour periods every fourth day.

2. High for year was 245

Source: Marlatt and Gelinas, 1975; Town of Vail



SOURCE: Town of Vail

FIGURE 6

limited by valley topography and mixing height. Mixing height is the distance above which little dispersion of pollutants occurs. The average cross-sectional parameters of the airsheds and their locations are given in Table 11 and Figure 7 on the following pages. Width is determined by the length along the centerline of the valley floor. Height is the mixing height. Theta 1 and theta 2 represent the angles at which the valley walls rise, since the walls are not perpendicular to the base.

The dispersion characteristics of the model require that the concentration of pollutants within the box must be equal to the difference between the pollutants emitted into the box, or brought into the box from upwind, and the pollutants removed through the downwind ventilation areas. Also, dispersion within the box was assumed to occur immediately since the atmosphere in the box must be assumed to be unstable, producing a uniform distribution of pollutants within the box. The ability to predict "hot spots" or areas of high concentration was thus eliminated by the use of an airshed model. The Gore Valley was divided into four airsheds, each defined by a separate development area having difference population densities and growth rates. These airsheds are Bighorn, East Vail, Vail Village and West Vail. The Upper Eagle Valley was divided into five airsheds. The Minturn airshed was located directly over the town of Minturn. The Dowd-Avon airshed was associated with the Eagle-Vail planned development. Benchmark and the lower part of the Beaver Creek development were in the Avon airshed. The upper and middle portions of the Beaver Creek planned development defined the Beaver Creek airshed. The Avon-Edwards airshed included the Arrowhead planned development.

The box model was developed in order to predict 24 hour (particulate) "worst case" episodes. It lacked specific mixing height data which had to be assumed. Worst case is defined as a period when poor dispersion conditions coincide with peak emissions. By taking a relatively high day for particulate emissions, December 20, 1975, and known recorded data on wind direction and speed for that day, the inversion or mixing height could be calibrated for the model. Several mixing heights were tested. Calculations using a mixing height of 92 meters produced a 24 hour average concentration of 226 micrograms per cubic meter (u/m^3), the same as those recorded on a relatively high 1975 day. (Peak day emissions may occur independently of the meteorological conditions used in the model.)

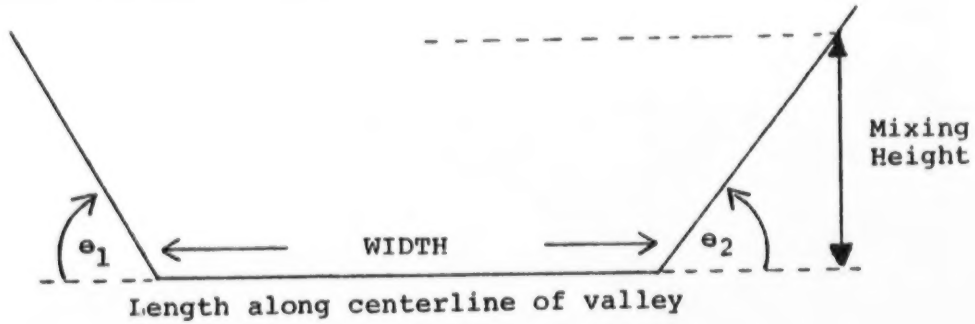
<u>Sources of Pollution, Particulates</u> -- Major fuel consumption in the study area consists of natural gas, liquified petroleum (LP) gas, and wood. Wood-burning fireplaces are a source of aesthetic enjoyment as well as heat. Historical consumption

Table 11

Average Airshed Cross-Sectional Parameters

Airshed	Width Kilometers (miles)		Height Kilometers (miles)		Theta 1(°)	Theta 2(°)
Bighorn	.5	(.3)	3.0	(1.9)	32.0	22.0
East Vail	.5	(.3)	3.7	(2.3)	29.0	25.0
Vail Village	.6	(.4)	3.7	(2.3)	14.0	18.0
West Vail	.6	(.4)	4.3	(2.7)	19.0	22.0
Minturn	.5	(.3)	3.5	(2.2)	27.0	12.0
Dowd-Avon	.9	(.6)	4.0	(2.5)	18.0	26.0
Beaver Creek	.6	(.4)	3.6	(2.3)	15.5	18.0
Avon	.9	(.6)	3.3	(2.1)	13.0	17.0
Avon-Edwards	.9	(.6)	4.0	(2.5)	11.0	14.0

SOURCE: Marlatt and Gelinas, 1975



Average Cross-Sectional Area

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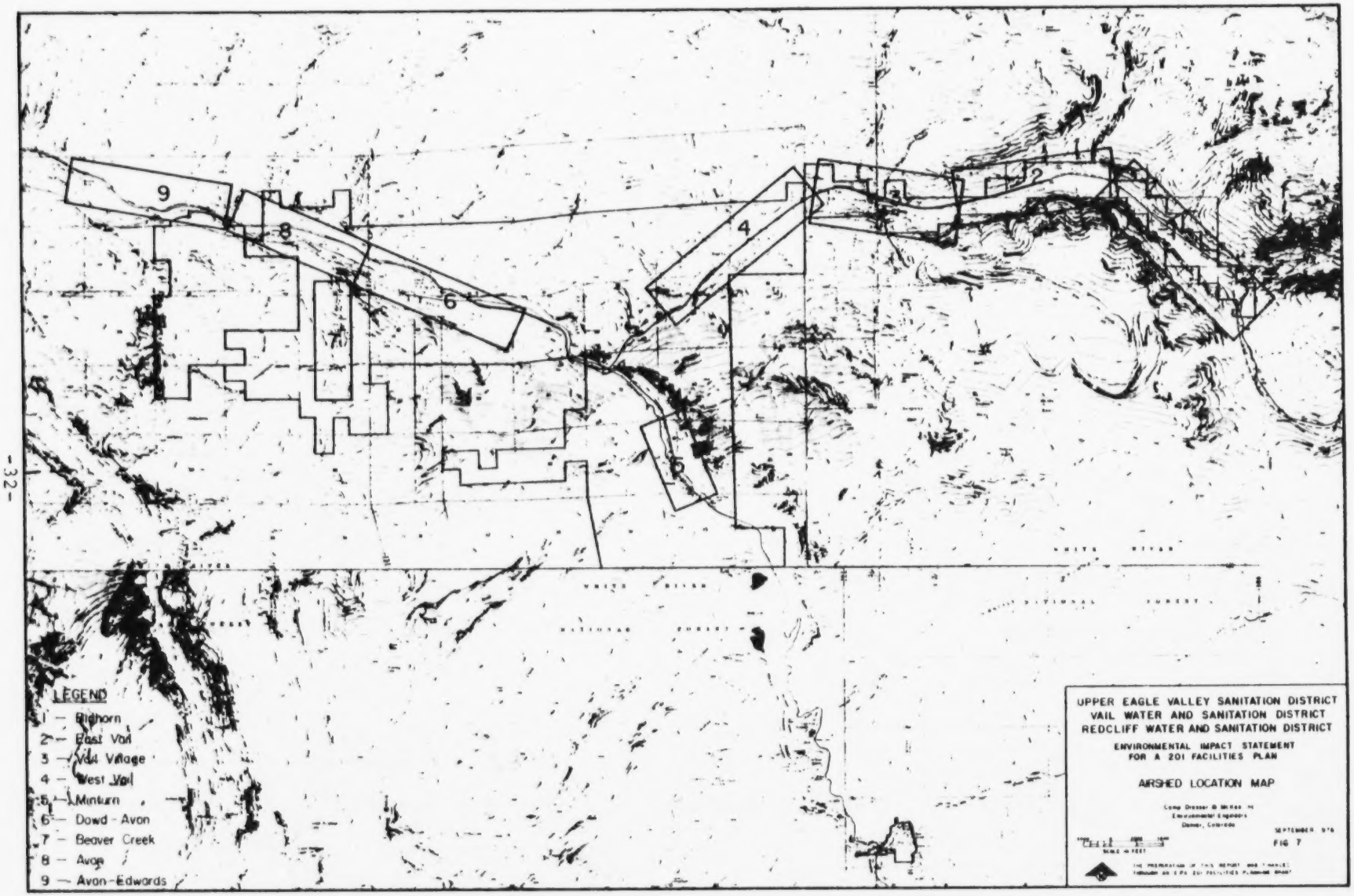

records for fuel consumption were utilized to calculate individual household use as well as total use by airshed. Seventy percent of gas and petroleum consumption occurs from November to April. During this six month period in 1975, an average natural gas customer used 140-150 thousand cubic feet. An average liquified petroleum customer used 14-15 hundred gallons per year in 1975. (The average LP gas consumption per customer was divided into each airshed total to obtain the number of LP gas customers.)

Data concerning 1975 fuel consumption by airshed was converted to heat units and expressed in terms of emission factors. Both LP and natural gas produce approximately the same amounts of particulate per equivalent heat unit, 6804 grams per 10^6 cubic feet (one gallon LP gas equals 100 cubic feet of natural gas). Assumptions regarding fuel consumption and emissions by airshed are summarized in Appendix C.

Fireplace contributions for particulates were based upon an EPA study of emission evaluations for fireplaces which were located in the state of Washington. The emission rate obtained for total suspended particulates was .02275 grams per second per fireplace. The emission factor has not been validated for the study area. Higher hypothetical factors have been utilized in other studies. The assumptions used in the model for number of fireplace units by airshed and by year are given in Table 2 in the Appendix.

Mobile source contributions to particulate levels include highway and off-highway sources, with highways being the major source. Emission estimates are based upon the following conditions: number and length of roads; type of roads (freeway, arterial, local); traffic volume; and, emission factors contained in EPA circular AP-42, 1976. Emission factors per vehicle mile for suspended particulates equal .54 grams per vehicle mile. Assumptions utilized in the model for vehicle counts and vehicle miles travelled are given in Appendix C Off-highway mobile source emissions come from trains--eight trains daily pass through Minturn and Avon travelling east or west. Each 15 minute trip through the study area is estimated to generate 283 grams per trip. Fuel consumption is estimated at 25 gallons per trip.

One other category which was not included in the analysis but which may prove to be a significant source of particulate matter is the dust from paved roadways. A major source of dust, in addition to urban runoff,in the study area is the application of sand during snowstorms. A preliminary report on a study showed dust emissions ranging from two grams per vehicle mile in commercial areas to 19 grams per vehicle mile in industrial areas. Although it is an important source, the data is not easily extrapolated or validated for the study area.

Sources of Pollution, Carbon Monoxide -- The sources for CO emissions are the same as those for suspended particulates. Only one source, vehicular traffic, was projected into the future due to the following:

- Very little data exists for CO emissions from fireplaces. Use of the Washington fireplace emission factors appeared questionable.

- The motor vehicle CO emission factors found in EPA circular AP-42, 1976, required further adjustment for altitude. The CO data for mobile highway sources is within an acceptable range of error; however, fireplace emissions could not be taken into account.

- In view of the above, gross total CO could not be estimated, or the relative contribution from each source.

Carbon monoxide emission factors used in the model are given below. As can be seen in the Table, emission factors are expected to decrease over time as a result of the vehicle emissions control program. Other assumptions calculated for traffic, speeds and vehicle miles travelled are given in Appendix C.

TABLE 12

Carbon Monoxide Emission Factors for Traffic

Road Type	1975	1980	1985	1990
Freeway	136.01	81.77	28.67	9.99
Arterial	159.20	101.98	38.81	13.72
Local	271.26	192.58	80.46	28.85

Noise

To establish the effects of noise from a particular source, total noise output should be taken into consideration. In the study area, no measurements have been made for background or ambient noise levels. However, the levels of noise for construction sites in the Gore and Upper Eagle Valleys can be estimated from current data. Suburban residential and urban residential noise levels at construction sites have been evaluated in EPA publications. The impacts section will address sources of noise as a result of the project.

THE BIOLOGICAL ENVIRONMENT

Terrestrial Vegetation

The flora within and around the study area vary widely with elevation, insulation, microclimate and topography. Elevations within the study area range from 2,300 to 3,048 m (7,400 to 10,000 ft). The climate is typical of the central Rocky Mountains, with wide ranges in precipitation, temperature and growing season due to topographic relief and surrounding mountain ranges. The growing season below 2,743 m (9,000 ft) is from mid-June to early September. Above 2,743 m (9,000 ft), freezing temperatures are possible during any month of the year.

The numerous vegetation types in the study area are grouped according to the dominant plant species into the following six terrestrial communities: aspen, mixed evergreen, spruce-fir, mountain brush, meadow and riparian. These plant associations are shown in Figure 8 on the following page. A list of common and scientific names of species by community may be found in Appendix D.

Aspen communities occur on moist sites between 2,286 and 3,048 m (7,500 to 10,000 ft) and are scattered throughout the study area. Aspen are distinctive because they are the only broad-leaved tree to form extensive communities on the uplands. Although aspen groves are dense, sufficient light reaches the forest floor to permit development of an abundant and diverse understory. Two major associations of aspen communities occur in the study area. The first type is found in areas of greater soil moisture and depth. The understory is luxuriant and contains snowberry and wild rose as the dominant shrubs. Peavine, vetch, arnica, geranium, tall larkspur, elk sedge and wild rye dominate the herbaceous stratum. The second type of aspen community is located on sites with drier, more rocky and shallow soils. Serviceberry, chokecherry and snowberry dominate the shrub stratum. Lupine, yarrow, aster and brome grass are some of the more common herbaceous plants.

The mixed evergreen forest is the prevalent vegetation type found in the study area. Lodgepole pine dominates the mixed canopy, with Engelman spruce and subalpine fir representing other dominant species. Aspen and Douglas-fir are considered subdominants and occur with less frequency in moist locations throughout this vegetation type. These dense mixed stands are distributed throughout the study area at elevations between 2,256 and 3,048 m (7,400 to 10,000 ft). The shrub and herbaceous understory of this community is generally very sparse due to the closed canopy overhead and acidic properties of the soil caused by the litter of the evergreen communities. Myrtle

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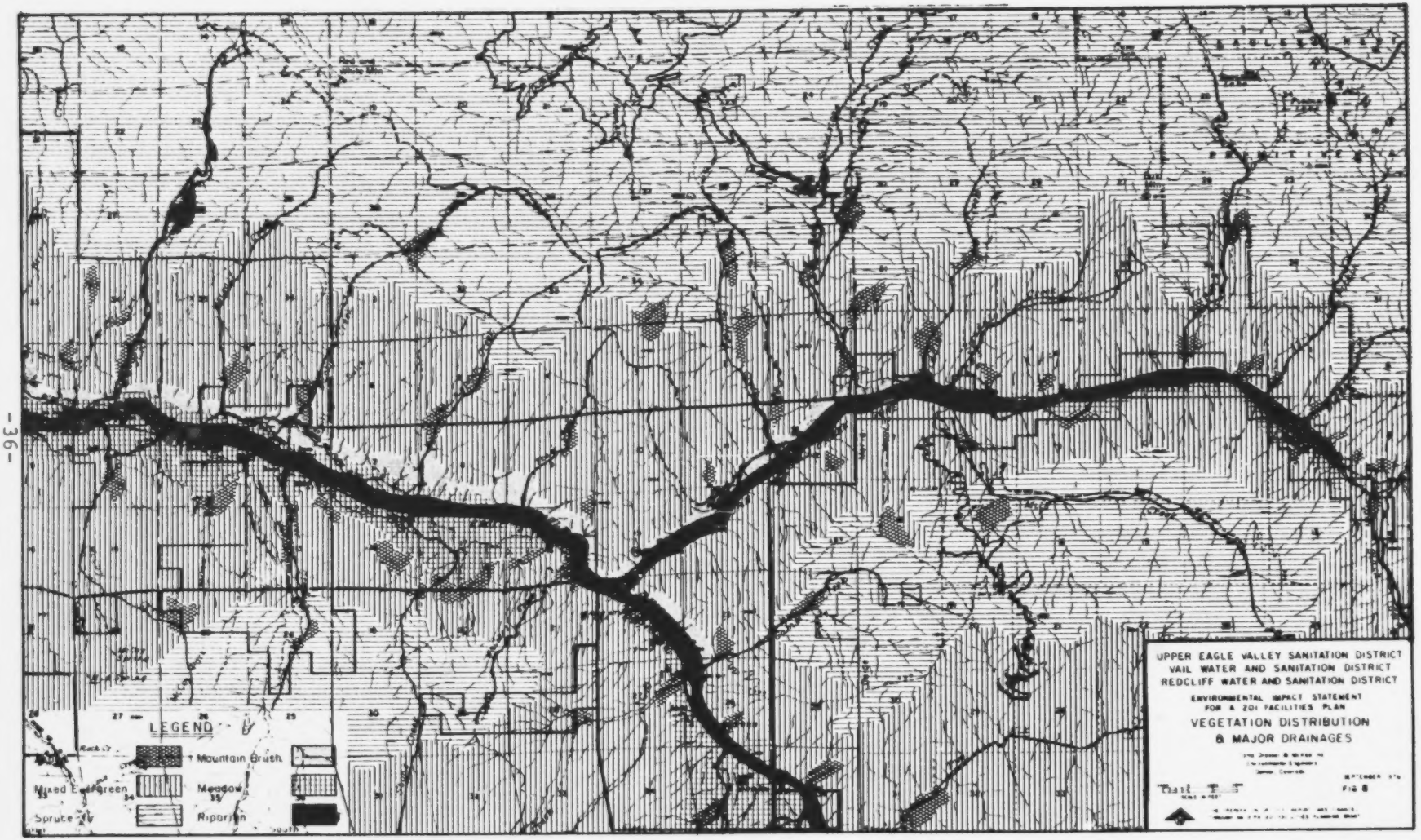


blueberry, mountain-lover, peavine, arnica and aster are the predominant herbaceous plants, with buffalo-berry, and wild rose dominating the typically meager shrub stratum.

The spruce-subalpine fir community is the dense, coniferous forest found between 2,743 and 3,048 m (9,000 and 10,000 ft). These cool, moist, high mountain forests form the most homogenous and continuous vegetation types found in the study area. The dense canopy is dominated by Engelman spruce and subalpine fir with aspen and lodgepole pine sometimes occurring in the subclimax stage. The tightly-packed canopy creates so much shade that the understory of myrtle blueberry, arnica, vetch and wintergreen is very sparse. The spruce-subalpine fir community is the climax coniferous forest type found in the upper regions of the study area. With control of fires and other disturbances, the aspen and mixed evergreen communities at these elevations will gradually be replaced by the spruce and subalpine fir community.

The meadow community occurs from 2,134 to 3,048 m (7,000 to 10,000 ft) within the study area. Its species composition varies from location to location due primarily to moisture conditions. Aspen, lodgepole pine or mountain brush communities may surround the meadow vegetation type. This community is dominated by grasses and sedges. Fescue, sedges, bluegrass, timothy and orchard grass are the dominant herbaceous species. Yarrow, thistle, plaintain, and dandelion are the most common herbs. Willows are the only shrubs found in this community. Lower meadows in the study area are used extensively for agriculture and support hay production and livestock grazing. Higher meadows in the study area are used primarily for livestock grazing and also provide a large portion of the food supply for some of the large wildlife.

Dry, southern exposures support the mountain brush community. It is found predominantly at lower elevations in the study area between 2,286 and 2,400 m (7,500 to 8,200 ft). Soils of mountain brush vegetation type are moderately deep, well-drained and rocky.

Species composition of the mountain brush community varies and depends upon soil parent material and soil moisture. This community is dominated by serviceberry, mountain mahogany and snowberry, with big sagebrush, buffalo-berry and bitterbrush occurring in lesser amounts. The herbaceous stratum is moderately developed with aster, yarrow, sulfur flower, wheat grasses, needle-and-thread grass and Indian rice grass as the more dominant species. Continued maintenance of the mountain brush community depends upon the high solar radiation received on southern exposures throughout the study area. This high solar radiation causes rapid evaporation of any available moisture, thus restricting growth to the mountain brush community which can grow on areas where reduced soil moisture conditions occur.

The riparian community occurs in narrow strips along the flood-plains of streams and rivers throughout the study area. The vegetation is rich and diverse relative to other communities in the study area. The riparian vegetation types are conspicuous to the casual observer because they occupy valley floors where, due to the more favorable topography, roads are usually constructed. However, the riparian vegetation actually constitutes only a minor part of the overall landscape. Groves of narrowleaf cottonwood trees form narrow, discontinuous bands along the rivers and streams. Mixed with the cottonwood groves are aspen, Douglas-fir, blue spruce, Engelman spruce and an occasional Rocky Mountain juniper. The understory of the riparian community consists of alder, dogwood, willow and Rocky Mountain maple in the shrub layer. The herbaceous understory is very diverse and represented by horsetail, monkshood, bluebell, cow parsnip, sedge, brome, three-awn grass, fescue, and wild rye as the more dominant species. The riparian community, because of its floral diversity, is considered a very stable vegetation type. However, it is dependent upon a constant supply of good quality water for maintenance.

Terrestrial Wildlife

The distribution of the wildlife in and around the study area is primarily influenced by vegetation distribution and topography. As noted in the previous section, vegetation within the study area can be grouped for the purpose of discussion into six communities. The wildlife of the area can also be grouped into either species which are almost entirely associated with one of the six vegetation types or species which lack definite vegetative associations. A list of common and scientific names of wildlife expected to occur in the study area is found in Appendix E.

Wildlife Associated with Vegetation Communities -- Most wildlife species occurring in the study area can be observed in two or more vegetative communities. However, the wildlife species discussed here represent the most characteristic species found in each vegetation type.

The riparian community is associated with the area's surface waters and is a focal point for numerous species that come for water. The only species of amphibians located within the study area are the tiger salamander and the leopard frog, which frequent ponds and slow-moving streams. Other species associated with the aquatic portion of this community are the mallard, the dipper, and the beaver. Birds found in riparian vegetation include: Baltimore oriole, great blue heron, Say's phoebe, yellow warbler and the red-winged blackbird. In addition to these species, most of the bird species inhabiting the mixed evergreen community may also be observed near water. The western jumping mouse is the only mammal restricted to the dense riparian vegetation.

The meadow community may be found on the broad floodplains in the lower portions of the study area adjacent to the riparian community or, to a more limited extent, in the higher elevations associated with the various forest or brush communities. The existence of this community depends to a large extent on the level of the underlying water table. Since the lowland meadows are closely associated with the riparian community, these two communities tend to overlap in their animal species composition. The western garter snake and the gopher snake frequent the lowland meadow. Both of these species, the only snake species found in the study area, inhabit the upper meadow community and adjacent upland communities. The most abundant bird species of the lowland meadows include the marsh hawk, killdeer, horned lark, western meadowlark and the savannah sparrow. Predatory birds such as the red-tailed hawk and the great horned owl frequent the lowland meadows for prey. Several small mammals which serve as prey for these raptors include Richardson's ground squirrel, northern pocket gopher, mountain mole and the longtail mole.

Species composition of the upland meadows is similar to that of the lowland areas; however, the higher elevations result in a shortened growing season and severe environmental conditions. The effect of the shortened growing season is an overall lowering of productivity and abundance of animals which inhabit this region.

Because of the similarity of animal species composition in the aspen, mixed evergreen and the spruce-fir communities, they have been grouped together as a single habitat type. A large variety of bird species,including the sharp-shinned hawk, blue grouse, broad-tailed hummingbird, hairy woodpecker and many species of songbirds inhabit the mixed woodland community. Mammals found here include the snowshoe hare, Uinta chipmunk, golden-mantled ground squirrel, and black bear.

Upper reaches of the mixed woodland community, primarily composed of stands of Engelman spruce and subalpine fir, experience severe environmental conditions. Dense canopy of the Engelman spruce effectively cuts the light level at the forest floor. This, coupled with the short growing season, drastically reduces the understory which most animal species rely on for food and shelter.

The mountain brush community occurs on dry, south-facing slopes within the study area. Because of the lack of moisture typical of southern exposures, few vegetative species are observed in the area. Similarly, few animal species are full-time inhabitants of this community. The sagebrush lizard and the eastern fence lizard commonly inhabit this community.

<u>Wildlife Species Lacking Definite Vegetation Associations</u> -- Some animal species lack specific associations with vegetation types

but "key" in on a particular aspect of their environment such as cliffs or brush for nestling, brush for cover, or a particular food source. Bird species fitting into this category include the golden eagle, American kestrel, great horned owl, barn swallow, violet-green swallow, rough-winged swallow, black-billed magpie, common raven, and mountain bluebird. Mammal species in this category include the white-tailed jack rabbit, least chipmunk, deer mouse, coyote, and bobcat.

The white-tailed jack rabbit inhabits open areas (e.g., mixed brush, meadow, mixed evergreen, and "edge" habitat) throughout the study area. The least chipmunk and deer mouse are the most numerous and ubiquitous of the mammalian species occurring within the study area. These species inhabit all vegetation types, with local abundance in brushy areas. Both the coyote and bobcat occur throughout the study area except in the spruce-subalpine fir forests.

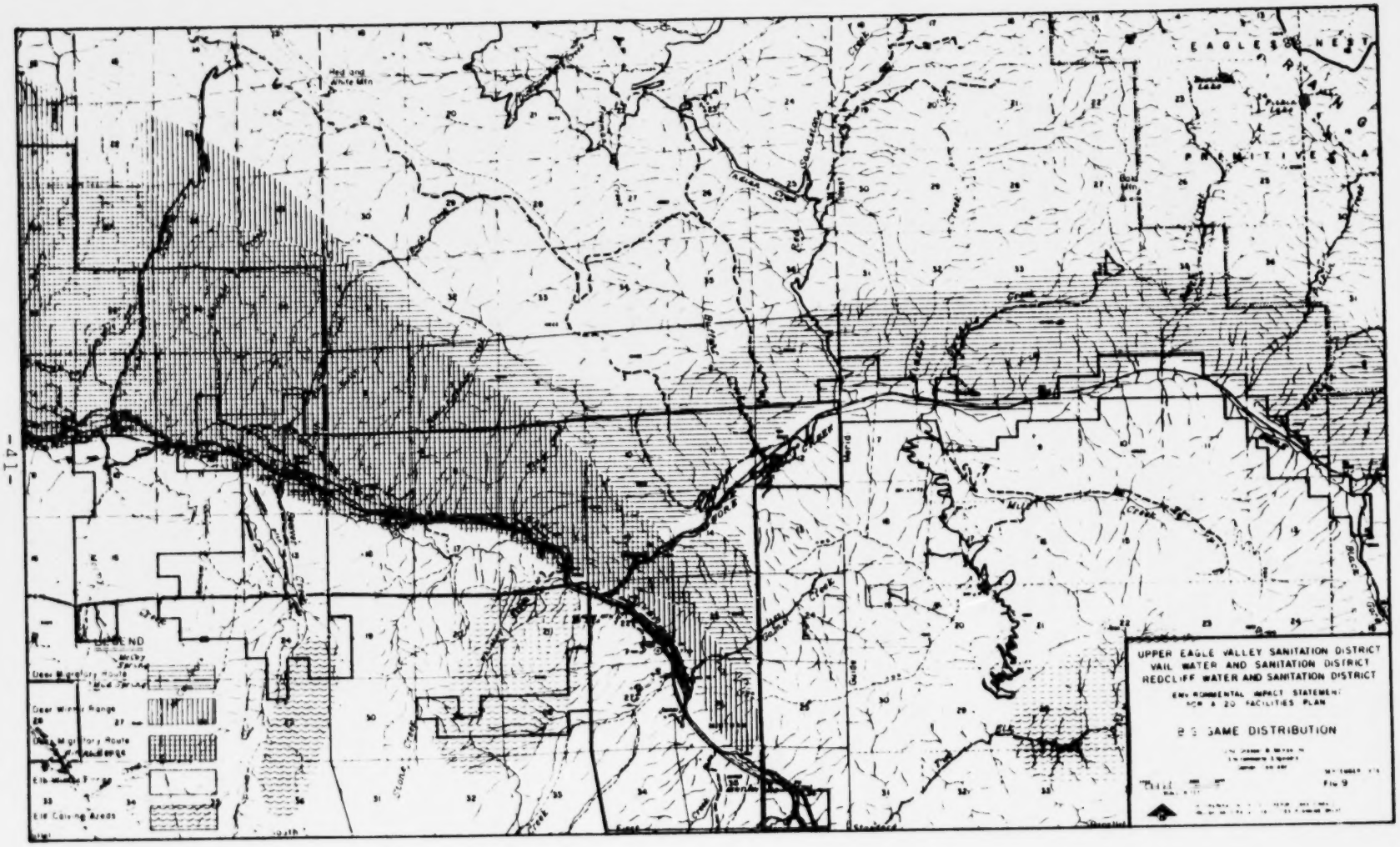
Game Species -- Game species,which are the objects of considerable hunter attention within Eagle County,include mourning dove, blue grouse, white-tailed rabbit, snowshoe hare, Nuttall's cottontail, elk, mule deer and black bear.

Mourning dove inhabit mountain brush, forest edge, and other brushy areas adjacent to water, while blue grouse inhabit mixed evergreen and subalpine fir vegetation.

Elk inhabit forest areas and higher elevation mountain brush throughout the study area during the summer. In the winter, elk move down to the mixed evergreen forest. The areas generally on south-facing slopes in the northern part of the study area from Avon to Dowds Junction south of the Eagle River from Dowds Junction to Red Cliff are either winter range or critical winter range for elk. In addition to the winter range, calving areas occur at elevations just above or overlapping with existing winter range.

The mule deer utilize mountain brush, mixed evergreen, meadow, riparian and forest-edge vegetation types of the study area, avoiding to some extent the fir forests. Most of the study area is summer range; however, a critical migratory route and winter range is also found immediately north of Gore Creek. Deer use this corridor to travel from summer range to winter northwest of Avon, as shown in Figure 9, on the following page.

Endangered and Threatened Species -- The peregrine falcon, listed on the federal endangered species list, is a potential year-round resident of this section of the Rocky Mountains. Favored habitat includes cliffs or bluffs for nesting, with adjacent riparian areas for hunting. Several locations within the study area provide both of these requirements, but it is presently unknown whether this species nests in the area.



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Aquatic Biology

Most of the upper Eagle River and its tributaries represent highly pristine, cold water mountain streams that support a diverse aquatic community. However, as these waters approach more populated regions of the study area, the quality of these streams decrease as does the diversity of aquatic organisms.

The major components of mountainous, cold-water biota include aquatic plants, aquatic invertebrates, and fish. Each of these is interrelated to one another and is dependent upon environmental factors.

Aquatic Vegetation -- The major source of plant material to mountain streams originates from outside sources such as terrestrial vegetation. This material enters the food chain within the streams and may be eventually consumed by several species of aquatic invertebrates.

Aquatic vegetation of rivers and streams is made up of phytoplankton (free-floating microscropic plants), periphyton (attached microscopic plants), and macrophytes (large attached plants). Except for two 1974 reports on Beaver Creek, no specific information is available on any of these forms of plant life in the Eagle River or its tributaries. In most high mountain, cold-water streams, annual productivity of these components is very low because of the lack of necessary plant nutrients, the cold waters, and the absence of sufficient amounts of sunlight.

Of the three forms of aquatic vegetation just mentioned, periphyton normally is the major source of in-stream production within mountain streams or rivers. Periphyton is responsible for the "slick" feeling of rocks and other materials in or near mountain streams.

Macrophytes, or large, attached aquatic plants such as pond lilies or cattails, usually contribute little to the productivity of mountain streams. Only two areas within the entire study area were noted to have any macrophyte production, one being below the old holding ponds of the New Jersey Zinc Corporation and the other below their new holding ponds. It is possible that these stands of cattails are a result of a rise in the groundwater level associated with the holding ponds.

Phytoplankton production is mountain streams is extremely low. The main source of phytoplankton to streams is usually overflow from lakes or ponds which maintain a standing crop of phytoplankton or from dislodged periphyton.

Aquatic Macro-invertebrates -- The composition of the aquatic macro-invertebrate fauna of a high mountain stream include a variety of species with representatives from almost all invertebrate phyla. Insects usually compose the major portion of the aquatic macro-invertebrate life in such streams. A number of insect orders have been identified from the waters of the study area, including mayflies, beetles, flies, mosquitoes and midges. Some of these contain species which occur only for a portion of their life cycle in the aquatic community, while others are entirely terrestrial. The order Hymenoptera (ants, wasps, bees, and sawflies), for example, is entirely terrestrial yet composes a large portion of the food supply of fish of the area.

Until recently, the most complete analysis of the aquatic macro-invertebrates of the Eagle River and its tributaries was conducted in October 1966 by the Federal Water Pollution Control Administration and published in their report of 1968. This report provides the best baseline information for the study area since the study was conducted before large-scale development of Gore Creek.

This report indicates the biological condition of the Eagle River up-stream from, adjacent to, and downstream from the influence of the industrial wastes of New Jersey Zinc Corporation in the mid-1960's. Generally, these data indicate that the condition of the Eagle River, at that time, was very good above Gilman. Near Gilman, water quality degenerated and was uninhabitable near the point where the effluent from the old New Jersey Zinc Corporation tailings ponds was discharged. The river did not significantly recover until a point near Dowds Junction. A copy of FWPCA data concerning the Eagle River is found in Appendix F.

A recent survey of the Upper Eagle River and Gore Creek by the Colorado Department of Health indicates similar conditions. The Eagle River above Gilman is an excellent fishery with a good macro-invertebrate population. Despite efforts by the New Jersey Zinc Corporation to control non-point source seepage from their tailings ponds, high levels of certain metals are still occasionally encountered within the Eagle River. The present macro-invertebrate fauna of the Eagle River between Gilman and Dowds Junction is still lower than its upper reaches, but some re-establishment has taken place. This probably has resulted from improved discharge quality from New Jersey Zinc Corporation tailings ponds. Spills of untreated mine tailings into the Eagle River occasionally create localized fish kills, but because they move through the area so rapidly, are thought to affect the benthic macro-invertebrate populations very little.

Limited macro-invertebrate data on Gore Creek during the 1966 sampling by FWPCA make analysis difficult. One station located approximately one mile upstream from Vail showed low species

diversity (eight species) and relatively low numbers of organisms (75 individuals) per square foot compared to the second Gore Creek station located one mile above the confluence with the Eagle River (17 species and 285 organisms per square foot). Based on the few samples taken by FWPCA, these data indicate that, as early as 1966, the town of Vail had influenced the aquatic macro-invertebrate constituency of Gore Creek, providing a more diverse population with greater biomass.

A survey of the aquatic insects in Gore and Black Gore Creeks was conducted in August 1971 in relation to the completion of I-70 over Vail Pass. It presents summer data, whereas the FWPCA provides only winter data. Results of bottom sampling and fish stomach content analysis indicate that, although mayflies represented by far the largest portion of the aquatic insects in Gore and Black Gore Creeks, they represented only 21 percent of the food items found in the stomachs of brook trout. Terrestrial insects provide over half of the food items found in brook trout stomachs. Although it is impossible to estimate the actual food biomass contribution by each species, the data indicated that the terrestrial species provide a much higher food contribution to brook trout than do the aquatic insects. This factor reflects the general lack of plant life available to aquatic insects in high-mountain streams.

The Colorado Department of Health study previously mentioned suggests, as does the FWPCA report, that the town of Vail may influence the aquatic biota of Gore Creek. Data from this study show that below the point of discharge of the Vail wastewater treatment plant there is a decrease of species diversity and an increase in the population of aquatic macro-invertebrates. Although the statistical validity of analysis of a single sample is questionable, the apparent discrepancy between these two studies may in fact indicate an alteration of Gore Creek's aquatic biota within the past decade.

Fish -- Although several cursory inventories have been made on the fisheries of the Upper Eagle River Valley, no annual or seasonal productivity estimate has been made. The Colorado Division of Wildlife has published a list of fish species known to occur within Eagle County; these are included in Appendix G. In addition to approximate species composition, an overall evaluation of several of the study area's streams was included in a statewide stream evaluation conducted by the Division of Wildlife in 1972. Results of this study are summarized in Table 13, on the following page. The Major Drainages Map, Figure 10, following Table 13, illustrates the location of the major tributaries. Although the rating system used in this evaluation is, for the most part, subjective, it acts as a general guide to indicate an overall evaluation of the area's fishery.

TABLE 13

COLORADO DIVISION OF WILDLIFE EVALUATION OF SELECTED

UPPER EAGLE RIVER BASIN TRIBUTARIES.

Creek	1972 Stream Evaluation Criteria													Approximate % Species Composition			
	Water Quality	Pool-Riffle Ratio	Temperature	Clarity	Fish Food Supply	Condition of Fish	Legal Access	Physical Acess	Need for District	Physical Condition	Meander	Rough Fish Competition	Total	Brown Trout	Brook Trout	Rainbow Trout	Native Trout
Homestake	8	9	9	9	9	9	8	9	9	4	10	10	103	70	9	20	1
Fall	10	4	4	10	4	2	10	1	6	8	1	10	70		40		60
Two Elk	6	5	5	5	5	-	10	2	7	6	4	10	65				
Cross	10	9	4	10	5	10	10	2	10	10	3	10	93		70		30
Black Gore	6	6	5	6	3	4	10	8	9	6	3	10	76				
Booth	9	5	5	9	-	-	10	2	7	10	5	10	72				
Red Sandstone	6	7	5	6	5	5	10	4	7	5	3	10	73		33	33	33
Buffehr	9	5	6	9	6	10	10	2	9	9	4	10	89			100	
Beaver	10	5	6	10	4	9	1	1	4	7	5	10	63				
Gore	2	9	8	3	9	8	8	7	9	2	8	10	83	60	10	15	15
Turkey	6	5	6	5	6	9	10	10	6	5	5	10	83			100	
E. Fork Eagle	7	8	8	8	8	10	10	5	-	4	6	10	84	90	5		5

SOURCE: Based on 1972 evaluation conducted by the Division of Wildlife. Rating on each criteria is from 1 (low or poor) to 10 (high or excellent). Total possible score is 120.

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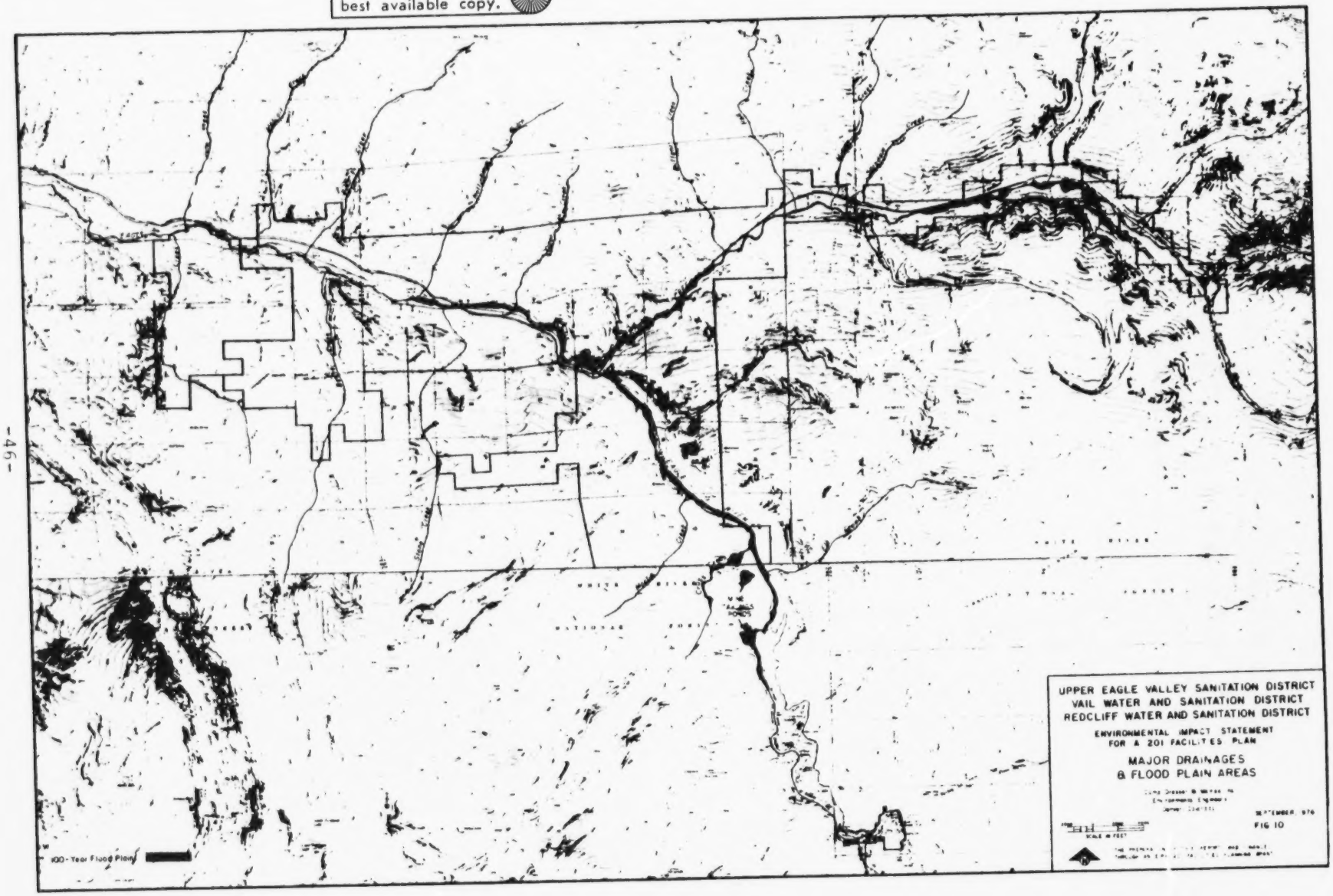


The Division of Wildlife is presently conducting a more detailed evaluation which will eventually provide more objective values. A discussion of the major fisheries of the study area, based on Colorado Division of Wildlife information and other pertinent data, is presented in the following paragraphs.

The upper reaches of the Eagle River south of the study area are characterized by high water quality. The favorable pool-to-riffle ratio and temperature provide good habitat for the fish population, which consists of 90 percent brown, five percent native cutthroat, and five percent brook trout. Successful natural reproduction makes stocking unnecessary.

The data indicate that the water and fishery qualities of Homestake Creek, a major tributary to the headwaters of the Eagle, are excellent. Of all the streams in the area, it receives the highest rating in the evaluation. Its diverse fishery species composition is: 70 percent brown, 20 percent rainbow, nine percent brook, and one percent native cutthroat. Although successful natural reproduction is reported, it is regularly stocked.

Black Gore Creek is characterized by good water quality and abundant natural fish reproduction. The stream receives some of the rainbows that are stocked into the Black Lakes on Vail Pass, a very popular fishing and camping ground, but is not stocked.

The fish population above Vail in Gore Creek consists of 60 percent brown, 10 percent brook, 15 percent rainbow, and 15 percent native cutthroat, occasionally supplemented by hatchery-reared rainbows. The fish population below Vail consists predominantly of brown trout which migrate out of the Eagle River to spawn.

Gore Creek has undergone several physical changes in channel design as a result of highway construction and development within the floodplain. Such activities have caused temporary water quality problems and destruction of aquatic wildlife habitat. The establishment of aquatic biota in new stream channels progresses rather rapidly; for short sections of streams, less than a year. Rechannelization of the lower portions of Gore Creek has caused a constriction of the stream which has proved to be beneficial to the fishery during periods of low flow. If extensive development of the floodplain in the vicinity of Vail has caused barriers to fish migration, it has not been documented.

The water quality of Beaver Creek is excellent, and trout reproduction is abundant. Five fish species were collected by electrofishing during the summer of 1972, including brown, rainbow, native cutthroat, and brook trout and Piute sculpin.

THE PHYSICAL ENVIRONMENT

The physiographic characteristics of the area, including topography, geology and soils, govern the suitability of the land for wastewater treatment plant site location, pipeline routing, and the application of effluent or sludge. The descriptions presented herein are accompanied by detailed appendices which address the engineering considerations inherent in the maps portraying the topography and the location of various rocks and soil formations.

Geology and Soils

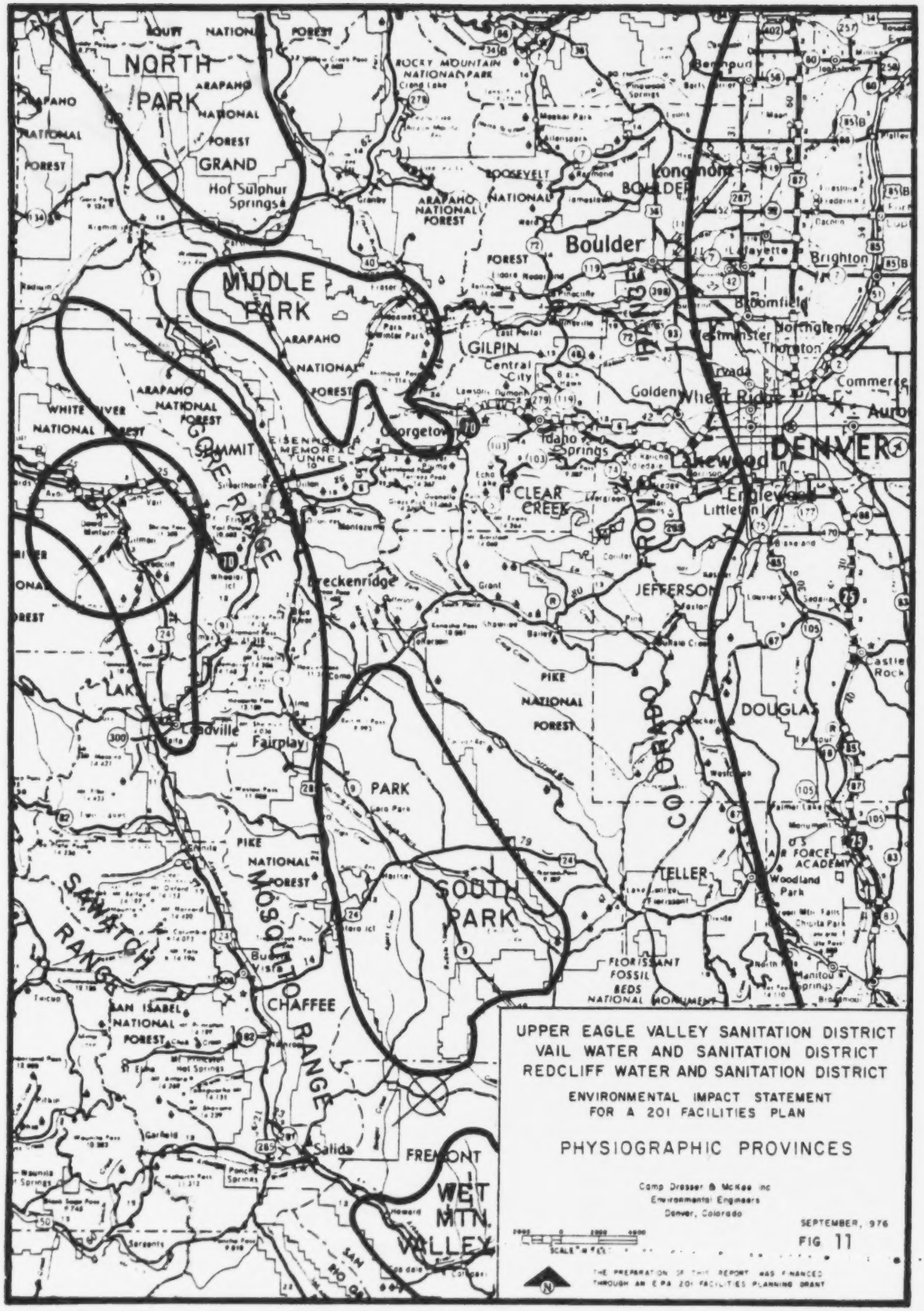
The boundaries of the Upper Eagle Valley, Vail and Red Cliff Sanitation Districts encompass private lands along Gore Creek and the Eagle River. The study area is surrounded by National Forest lands, except for the western boundary where the Eagle River Valley widens out to privately-owned irrigated farmlands and ranchlands.

The geologic location of the study area is the Southern Rocky Mountain Physiographic Province between the northern end of the Sawatch Mountain Range and the western flank of the Gore Range, as shown in Figure 11,on the following page. The altitudes have been discussed under Terrestrial Vegetation.

Snow Avalanche Hazard -- As a result of the elevation, topography and climate of the area, varying degrees of avalanche hazard exist. Numerous active avalanche tracks may be seen on north-facing slopes within the study area. Figure 12, on the second following page, depicts the varying degrees of avalanche risk for the area.

Bedrock Geology -- The rock units in the study area are of sedimentary origin, with the exception of three small areas of Precambrian granitic rocks, consisting of only a few acres each, on the southern and eastern edges of the area. Figure 13, following Figure 12, shows the location and extent of each bedrock unit in the study area. In Appendix H, each bedrock unit is described as to physical characteristics (weathering characteristics, erodibility, engineering characteristics, and potential or actual resources). These characteristics apply to depths 24 to 60 inches beneath the ground surface. The section on Soils and Surficial Deposits will address characteristics of the first 40 to 60 inches of ground surface.

Geologic Hazards and Engineering Geology -- The map of Geologic Hazards and Engineering Geology, Figure 14, following Figure 13, should be interpreted together with Appendix I, which describes suggested planning and precautionary measures



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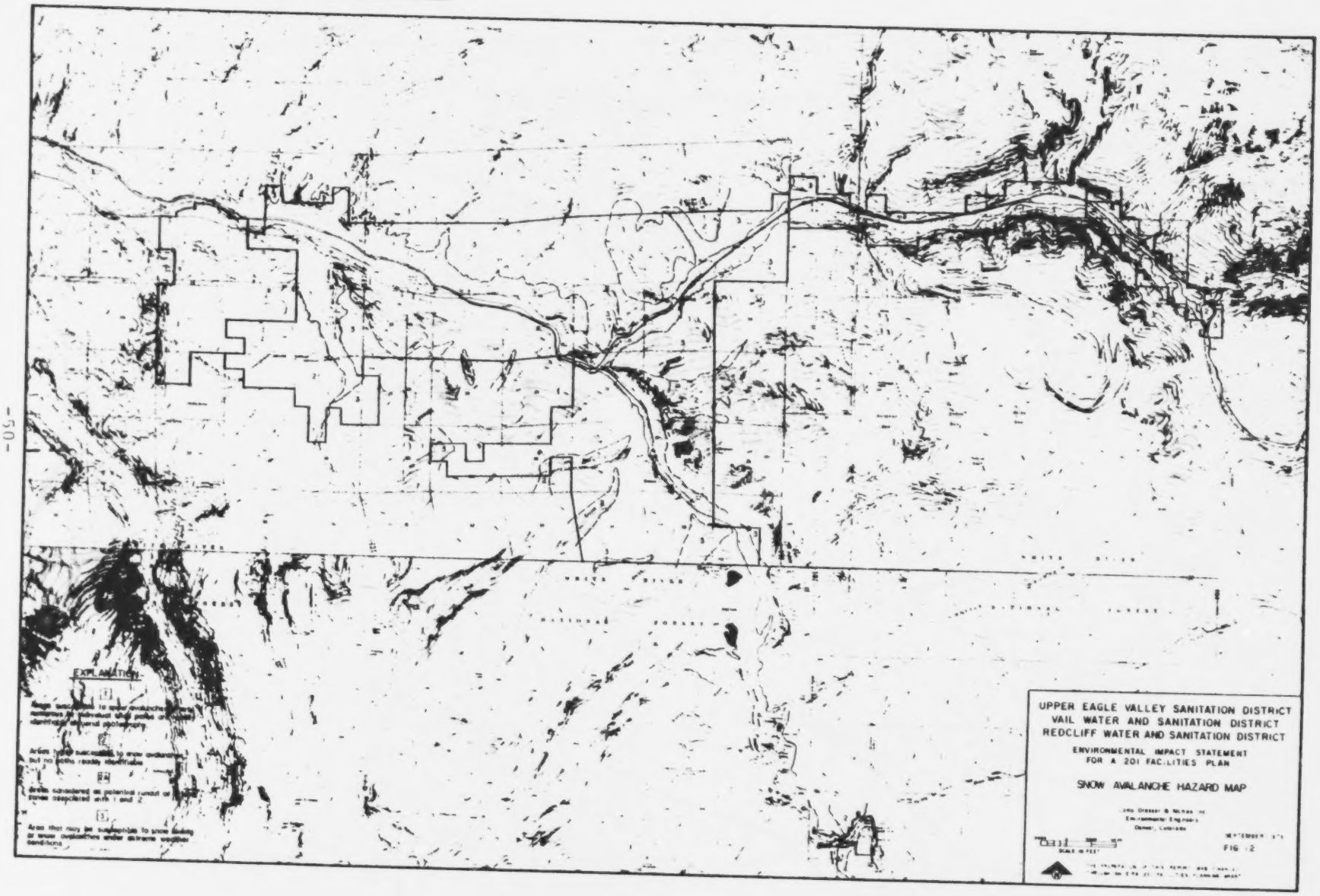

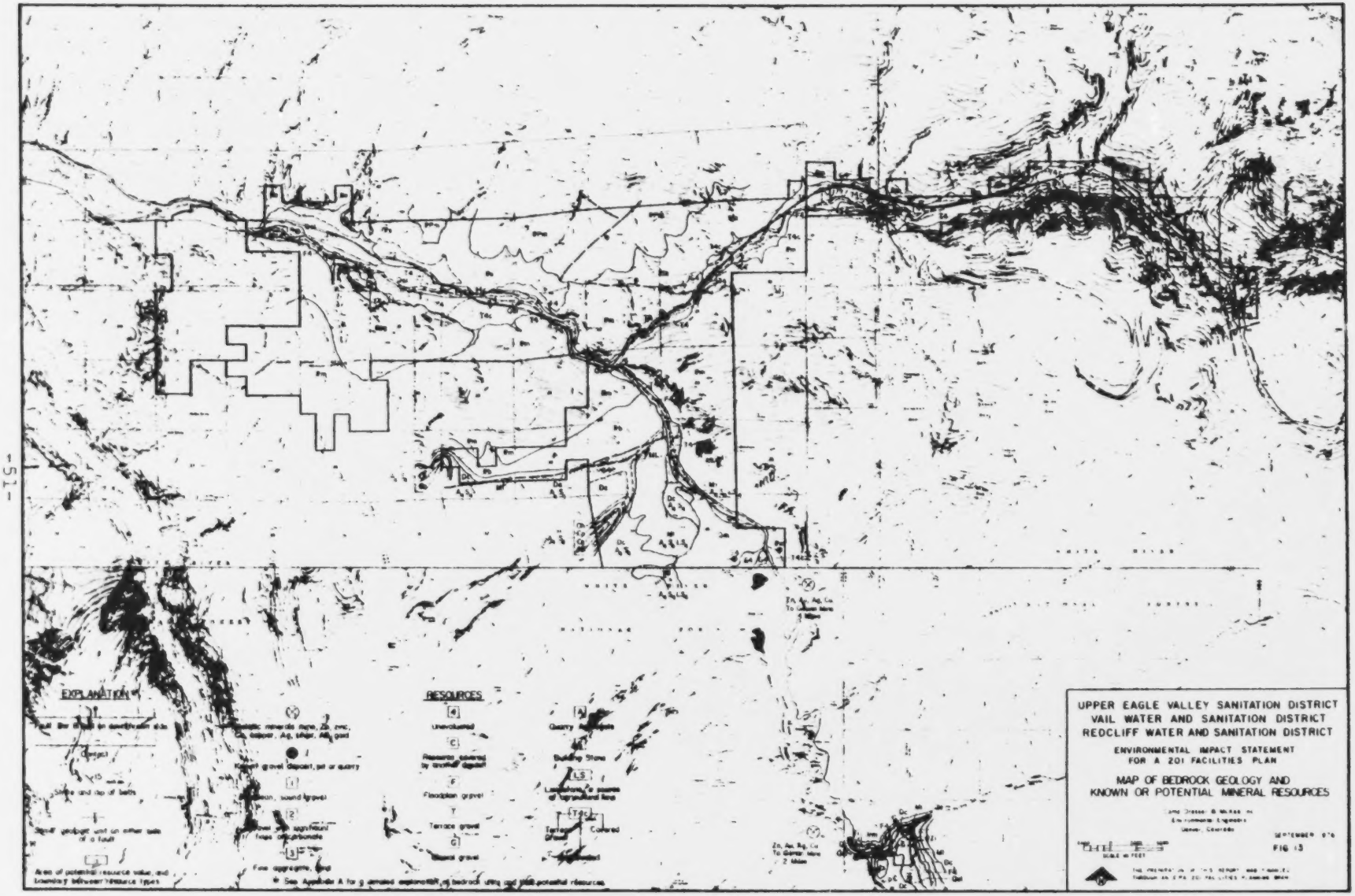

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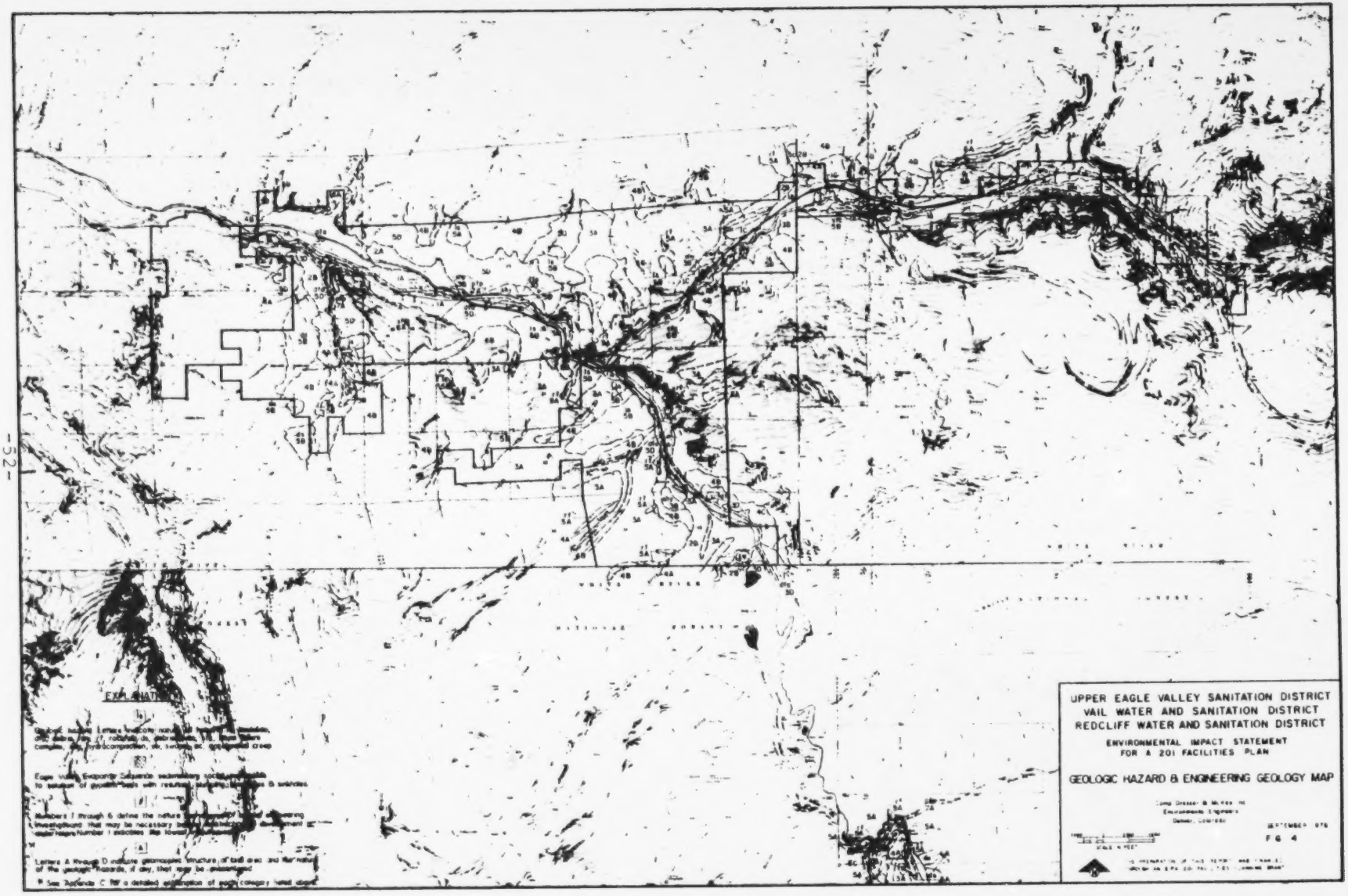

that should be taken before development of various types of lands within the study area. Considerations used in compilation of the map included the bedrock type, soil type, slope, vegetation, snow avalanche hazard, and geologic hazards within each area. (This map was used as a planning guide, and should not be substituted for on-site tests prior to construction.)

Seismicity -- Although the seismicity of the region is not well-known, five major faults have been identified in the area. A two-year study is presently under way by the Colorado Geological Survey to evaluate the seismicity of Colorado. From preliminary information, the area west of longitude 104 degrees (along the eastern line of the Front Range), can expect earthquakes of a maximum Richter intensity of between 4 and 5. Richter intensity 2.5 is defined as a barely-felt earthquake. Richter intensity 5 may cause slight damage in well-constructed buildings or moderate damage to poorly-constructed ones.

Mineral Resources -- Between Red Cliff and the Dowds Junction area lies the Battle Mountain or Red Cliff mining district. Initial discoveries of gold and silver took place in 1879 in a mineralized portion of the Leadville Limestone. Copper and zinc content of the ore increased with depth, and throughout the 1930's, the mining district produced approximately 85 percent of the copper and 65 percent of the silver output of Colorado. Today the Gilman zinc mine, two miles north of Red Cliff, is operated by the New Jersey Zinc Corporation.

Other minerals of potential economic significance within the study area are confined to glacial and fluvial gravel deposits, potential evaporite deposits in the Eagle Valley Evaporite sequence, and potential building block, aggregate, riprap and agricultural lime in the pre-Pennsylvanian sequence in the southwest portion of the study area. Five gravel pits exist in the area, two at the junction of Cross Creek and the Eagle River, and three near Avon. The Minturn formation was prospected for uranium but no deposits of economic value were located.

Soils and Surficial Deposits -- This section presents the engineering geology and geologic hazards of the first 40 to 60 inches of ground surface. It is this area which is critical in considering revegetation, erosion hazard, water-holding capacity, runoff, plant nutrient levels and potential irrigable areas. Soils classifications and surficial deposits appear in Figure 15, on the following page. A complete description of each soil category, its geomorphic structure and type, appears in Appendix J which also includes an evaluation of the suitability of each for septic systems, landfill, topsoil, foundations, roadfill and irrigation.

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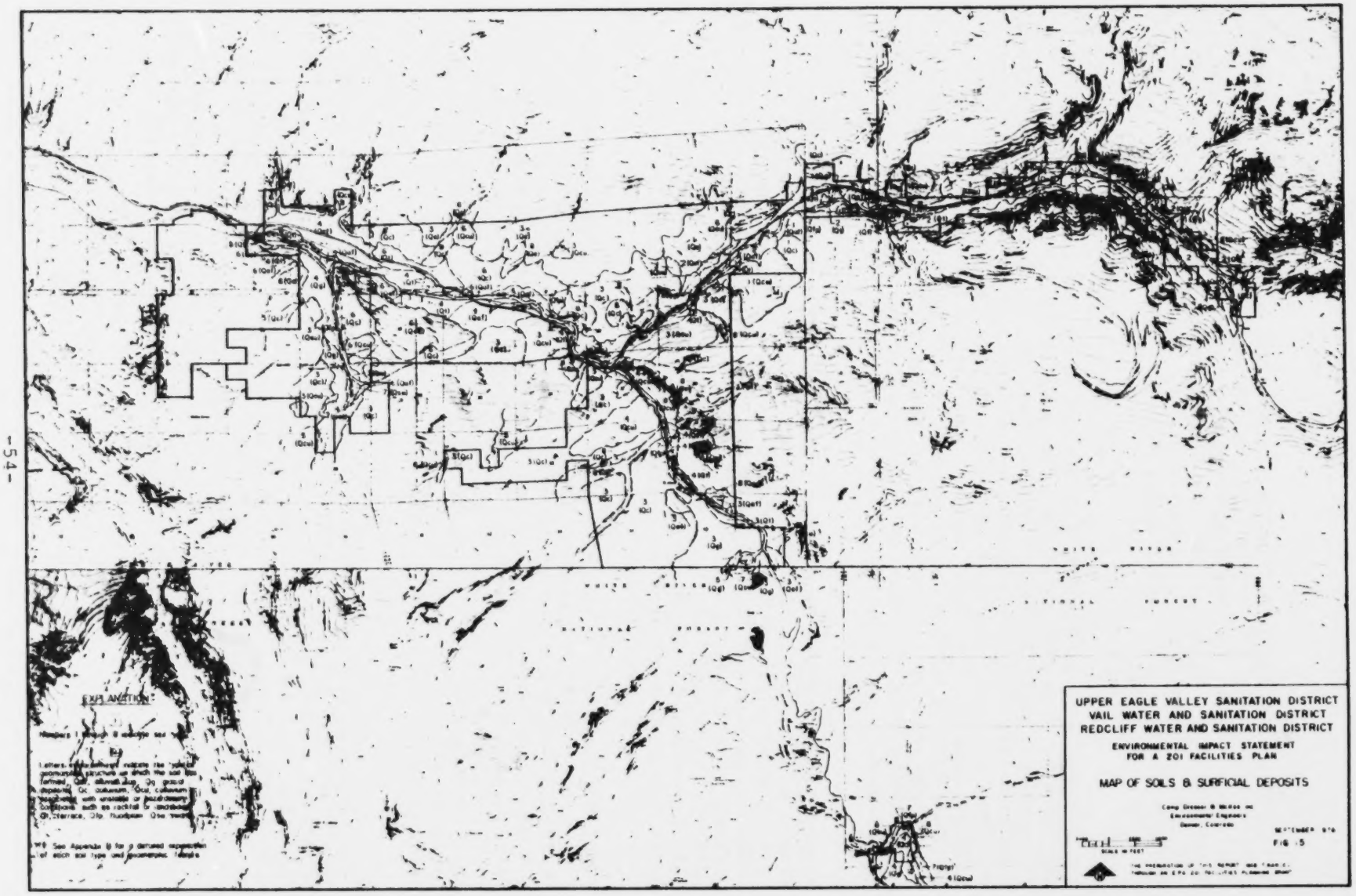


The soils in the area are stony, gravelly loams and clay loams. The pH is generally well within limits for normal plant growth. Slopes are generally greater than 20 percent, except on alluvial fans, terraces and stream bottoms where slopes vary from 6 percent to 20 percent. Permeability is usually moderate to rapid, runoff is moderately low, and the potential for frost action or shrink/swell is low to moderate.

Soils are generally neutral to slightly acid on the wetter, northern exposures, where heavier vegetation and a greater amount of organic acids cause more soluble chemicals to leach from the upper soil horizons. On drier, southern exposures, soils tend to be neutral or slightly alkaline. Chief obstacles to excavation and construction of waste disposal sites will be excessive stoniness and moderate to rapid permeability. Inhibiting factors for revegetation will be steep slopes and rapid erodibility once the natural root mat is removed.

In the western portion of the study area, from one mile west of Dowds Junction to the Arrowhead area, alkaline soils are common on the hills above the stream terraces. These soils have formed over evaporites which release potassium, sodium and calcium ions into the soil, increasing alkalinity and salinity. They approach the upper limits of alkalinity for normal plant growth, and will be more difficult, in terms of revegetation, to reestablish natural plant communities.

Field investigations indicate little to no irrigated land within the boundaries of the study area. River terraces in the south and east are too steep and narrow. Potentially irrigable land exists in the western portion of the area, along terraces of the Eagle River. This land was irrigated in the past, but it has now been subdivided and is not cultivated.

Hydrology and Water Quality

The surface waters in the vicinity of the study area consist of high-mountain, cold water streams, scattered beaver ponds and small lakes. Major drainages were shown in Figure 10. The Eagle River and its tributaries contribute the major portion of the surface water volume. High flow periods in these streams occur during the spring snowmelt (May and June), while low flows occur most frequently during the winter period of December through February and the late summer months of August and September. Elevations of the streams range from 2,743 m (9,000 feet) on the upper extremities of Gore Creek and the Eagle River to less than 2,286 m (7,500 feet) on the Eagle River near Avon. Annual precipitation varies from 45.7 cm (18 inches) near Avon to over 114.3 cm (45 inches) at higher altitudes. Two-thirds to three-fourths of this occurs as snowfall.

Stream Identification and Water Supply -- There are 32 major tributaries to the Eagle River in the study area. U. S. Geological Survey monitoring stations are located on sixteen of these. Appendix K contains average and extreme discharges for each station for the period of record.

Precise hydrological data are not available for the Eagle River near Avon. Available data indicate that the Eagle River below Gypsum drains a watershed of 2.445 km^2 (944 square miles) with a mean annual discharge of 508 x 106 m^3 (412,200 acre feet) per year.

Periods of low flow are associated with seasonal extremes in water temperatures. The lowest annual water temperatures occur during the winter low flow period, while the highest typically occur during the summer low flow. Decreased dilution capability in the streams during these periods often results in maximum concentrations of dissolved chemicals. For this reason, calculations of the allowable discharge of various types of man-produced pollutants in order to meet stream water quality standards, are based upon low flow levels. The three techniques for calculating critical low flows used most often in Colorado are Average Low Flow, 7-day/10-year Low Flow and The Sag Chain Determinations of Low Flow. For the purposes of this report, the 7-day/10-year Low Flow method has been utilized since it conforms to the 303(e) study approach and the methodology adopted for other water quality planning efforts.

With adoption of PL 92-500 in 1972, and the subsequent National Pollution Discharge Elimination System, it became essential to establish low flow data (for discussion see the following section). EPA attempted to solve the problem by developing the 7-day/10-year low flow criteria. The 7-day/10-year low flow represents a calculated low flow determined by averaging the

lowest flows of a stream recorded for a period of seven consecutive days which would occur within any ten consecutive year period. Many federal and state agencies are now considering adoption of this method to determine maximum allowable discharge of pollutants into surface waters. Table 14, on the following page, lists the 7-day/10-year low flows determined for several of the creeks of the study area.

Flood Hazard -- The opposite extreme of low flow is high water which accompanies spring runoff. In excess of 80 percent of the total annual discharge of several sub-basins of the Eagle River drainage occur during this time. The physical forces accompanying these high flow periods bring about high suspended sediment loads and debris which may be detrimental to aquatic life and often cause habitat destruction. However, these periods are also a time of dilution and flushing of toxic substances from the streams as well as a time of increased food supply washed in from surrounding terrestrial environment. Extremes in high water level also can cause physical destruction of human habitat.

Figure 10 illustrated the 100-year flood plain for the Eagle River and Gore Creek compiled from two previously conducted studies, one by the U. S. Geological Survey (USGS) and the other by Hydro-Triand, Ltd. for the Colorado Water Conservation Board in 1975. Human habitation in the Eagle River and Gore Creek valleys remains predominantly in or near the flood plain. The flood plain has been modified by constructing roads and buildings, thereby increasing the flooding potential during periods of high flow.

The Hydro-Triad report showed that: 1) although many areas in Vail may become flooded and experience water damage and sediment deposition, probably little significant structural damage would result directly from the 100-year flood, 2) significant structural damage may result indirectly from the flood if large amounts of debris or boulders were moved,3) the 100-year flood represents a serious hazard to humans who might be caught in the flood waters. Public Law 92-500, and the instructions issued by the Army Corps of Engineers in implementing Public Law 93-234, require special consideration in design where wastewater treatment facilities are located in the 100-year flood plain.

Aquifer Groundwater -- The groundwater aquifers of this region are not well mapped due to the irregular stratigraphy. Due to normally low yields of deep groundwater wells in this area, they are seldom used as domestic or agricultural supplies.

Deep aquifer groundwater in this area usually contains few dissolved solids but may occasionally contain high concentrations of trace elements which reduces its potability.

TABLE 14

MONTHLY 7-DAY/10-YEAR LOW FLOW LEVELS (in cfs) FOR VARIOUS SUB-BASINS OF THE EAGLE RIVER

Watershed	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Gore Creek	13.5	12.7	13.9	19.0	42.5	115.0	31.0	18.7	13.9	12.1	15.5	13.4
Eagle River above Gore Creek	35.0	33.0	36.0	49.1	109.8	296.0	80.2	48.3	36.1	31.3	40.3	34.6
Eagle River from above Gore Creek to below Beaver Creek (excluding Gore Creek)	6.1	5.8	6.0	7.6	16.1	44.0	12.4	8.0	6.2	5.4	7.0	6.1
Eagle River from below Beaver Creek to below Squaw Creek	16.1	15.2	14.8	17.1	32.7	89.0	26.2	19.0	15.3	14.0	18.2	16.0
Eagle River from below Squaw Creek to above Brush Creek	19.1	18.0	16.5	17.1	29.1	81.0	25.0	20.8	17.2	16.4	21.5	19.0
Eagle River from above Brush Creek to below Brush Creek	31.4	29.8	25.9	23.8	34.2	101.0	33.1	31.5	27.1	26.5	35.2	31.1
Eagle River from below Brush Creek to below Gypsum Creek	28.9	27.5	22.8	18.5	20.5	65.0	24.1	27.0	24.2	24.2	32.3	28.7
TOTAL - Eagle River below Brush Creek	150.0	142.0	136.0	152.0	285.0	790.0	232.0	173.0	140.0	130.0	170.0	149.0

SOURCE : Nelson, Haley, Patterson and Quirk, Engineering Consultants 1975

Although groundwater does not contribute significant amounts to domestic water supplies through wells, an indirect contribution may exist through groundwater issuing from springs and seeps to surface water supplies. This may sustain the flow of streams during periods of low flow, providing for the maintenance of both aquatic and terrestrial flora and fauna at critical times of the year. In fact, groundwater contributes approximately one-third of the total Eagle River annual discharge in the vicinity of Gypsum.

Alluvial Groundwater -- Alluvial groundwater is derived from the alluvial or valley-fill deposits, associated with streams. The permeability of these deposits provides excellent storage capacity for water during high flow periods, which is released during low flow periods to adjacent streams. A number of successful wells yielding up to 570 liters per minute (150 gpm) have been drilled in the Upper Eagle River valley alluvium. The extent of this aquifer is presently unknown and the irregularity of its shape has been demonstrated by unsuccessful drillings near the valley edge. Because of this, alluvial groundwater is considered as surface water rather than groundwater under Colorado water law, controlled by surface water rights administration. Because the valleys are narrow, large withdrawals of water from alluvial wells in the area affect stream flow within a short period of time, and major diversions of stream water quickly affect the water level of the alluvium. The permeable material making up these valley-fill deposits control the water flow between these two sources, and also contributes significantly to the normally high dissolved chemical content of alluvial water.

Alluvial groundwater may contain high levels of calcium and magnesium bicarbonates and sulfates and other dissolved salts, especially in areas of heavy irrigation. A large portion of the alluvial deposits in the lower portions of the study area are underlain by basalt, a highly erodible material which may contribute additional amounts of dissolved solids to alluvial groundwater in the area.

Surface Water -- In Colorado, the quality of surface water is controlled by the Water Quality Control Commission of the Colorado Department of Health. State surface waters are classified according to water quality criteria and waste discharges are controlled by a discharge permit system. Programs and regulations regarding surface water quality standards and pollutant discharges are discussed in detail below.

The upper reaches of the Eagle River and its tributaries have been classified as B_1 by the Colorado Department of Health, and are described as "waters suitable or to become suitable for all purposes for which raw waters are customarily used, except primary contact recreation such as swimming and water skiing".

However, near the more populated reaches of the study area, the streams acquire concentrations of some undesirable material. Certain chemical compounds and water quality parameters warrant particular attention. These include: 1) Ammonia and other forms of nitrogen, 2) dissolved oxygen, 3) temperature and pH, 4) pesticides, 5) heavy metals and 6) chlorine residual.

Ammonia -- Raw domestic sewage normally contains from 20 to 40 mg/l of nitrogen, of which about 75 percent is in the form of ammonia, nearly all of which exists as ammonium ion (NH_4+). Most secondary treatment facilities remove approximately 25 percent of the total ammonia, leaving 12 to 30 mg/l of ionized ammonia in the effluent. Under aerobic conditions (that is, where air is present), certain nitrogenous bacteria eventually oxidize ammonia to nitrite (NO_2-) and nitrate (NO_3-). This is a natural process called nitrification which takes place in streams, lakes and rivers which receive loads of dissolved ammonia.

Un-ionized ammonia (NH_3), as opposed to ammonium ion (NH_4+), has been identified as being highly toxic to aquatic biota. The ratio of un-ionized ammonia to total ammonia is highly dependent upon temperature and pH. At temperatures and pH values normally encountered in sewage and receiving streams, usually less than ten percent of the total ammonia is in the un-ionized form. During the winter when stream temperatures are near freezing, this ratio may decrease to less than one percent.

The mechanism of ammonia toxicity is not clearly understood. Originally, it was thought that high levels of ammonia prevented exchange of metabolic gases at the gill surface of fish. However, recent studies suggest that high concentrations of ammonia, especially un-ionized ammonia, interfere with the excretion of naturally produced ammonia from fish. The accumulation of ammonia within fish causes physiological problems which initially affect the central nervous system. Chronic exposure to sublethal concentrations appears to cause detrimental changes in the cells on fish gill surfaces which, in turn, cause additional stress making the fish less resistant to infection by other pathological conditions. The pH of water, as noted earlier, is important in the control of the proportion of the toxic un-ionized form of ammonia present. However, if high levels of dissolved carbon dioxide or bicarbonate are found within the system, the actual pH at the gill surface of fish often remains sufficiently high to prohibit the uptake of the un-ionized ammonia. High concentrations of total dissolved solids also cause a decrease in the toxic effects of un-ionized ammonia in some instances. On the other hand, low levels of dissolved oxygen increase its toxic effects.

Natural levels of ammonia in Black Gore, Bighorn, Mill and Redstone Creeks, and other relatively undisturbed streams, are either very low or below the limit of detection. However,

concentrations increase significantly in water courses near populated areas. The primary sources of surface water ammonia in the study area, as identified by the Colorado Department of Health, are the Vail, Avon, and Red Cliff sewage treatment facilities, and outflow from the tailings ponds of the New Jersey Zinc Corporation located near the town of Gilman.

Relatively high un-ionized ammonia levels have occurred in Gore Creek downstream from Vail, and in Cross Creek and the Eagle River in the vicinity of the New Jersey Zinc Corporation tailings ponds, and in the Eagle River downstream of the Avon Sewage Treatment Plant. Peak values as high as .07 mg/l in Gore Creek, .142 mg/l in Cross Creek, and .02 mg/l in the Eagle River have been recorded, and in both Gore Creek and Cross Creek, average levels above .02 mg/l have been documented.

Considerable research has been performed to investigate the toxicity of ammonia (un-ionized) to various species of fresh water fish. The following is a brief summary of this research.

- As shown in Table 15 on the following page, a relatively wide range of LC_{50} (concentration at which 50 percent are killed over a given time period) values have been observed by various investigators for certain species of trout. The most consistent 96 hours LC_{50} value seems to lie between 0.2 and 0.4 mg/l, but most authors agree that the actual value is highly dependent on other factors, and can only be accurately determined for a particular stream with an in-situ investigation.

- It has been shown by Ball that over short periods (36 hours or less), rough fish are less susceptible to ammonia toxicity than trout, but for extended periods, virtually all fish are equally affected. Furthermore, it has been shown that fish are more sensitive to ammonia than most other aquatic organisms.

- Most investigators point out that many other factors influence the toxicity of ammonia, including pH, temperature, alkalinity, carbon dioxide, sodium ions, and the presence of other toxins. Some of these constituents affect the portion of the total ammonia content which is in the un-ionized form, while others react with the ammonia to form more or less toxic compounds. An acceptable value for total ammonia should be derived through in-situ bio-assays, before an LC_{50} value for un-ionized ammonia can be determined.

- In determining allowable concentrations for un-ionized ammonia, the emphasis has been to establish a relation between the maximum level which can be tolerated by fish in the most sensitive portion of their life cycle

TABLE 15

SUMMARY OF RESEARCH ON AMMONIA TOXICITY

Organism	Toxicity mg/l as N Un-ionized Ammonia	Source
Rainbow trout	0.4 96 hr. LC_{50}	Lloyd and Herbert (1960)
Rainbow trout	1.5 LC_{50}	Merkens and Downing (1957)
Rainbow trout	0.4 24 hr. LC_{50}	Ball (1967)
Rainbow trout	0.5 96 hr. LC_{50}	Herbert and Shurben (1963)
Rainbow trout	0.4-0.58 24 hr. LC_{50}	Herbert and Shurben (1965)
Rainbow trout	0.39 24 hr. LC_{50}	Lloyd and Orr (1969)
Rainbow trout	0.18 48 hr. LC_{15}	Ball (1967)
Rainbow trout	0.09 48 hr. LC_{5}	Ball (1967)
Rainbow trout	0.55 44 hr. LC_{5}	Ball (1967)
Suckers, Trout	4.0 96 hr. LC_{100}	McKee & Wolf (1963)
Brook trout	2.5 24 hr. LC_{100}	McKee & Wolf (1963)

and the specified LC_{50} value determined for the waters in which the fish live. The ratio between the tolerable and toxic limits is termed the "application factor," and recommended values for this application factor vary over a wide range. They include 0.1 x 48 hr. LC_{50}, 0.12 x 96 hr. LC_{50}, and 0.05 x 96 hr. LC_{50}. Therefore, because of the differences in opinion on LC_{50} values and application factors, the recommended tolerable limit could vary substantially. Some researchers recommend 0.02 mg/l (as Nitrogen) as a maximum limit.

One recommendation, as stated in an EPA publication, entitled Ammonia Toxicity, is quoted below:

> "Once a 96-hour LC_{50} has been determined using the receiving water in question and the most sensitive species, in the most sensitive portion of its life cycle in the locality as the test organisms, a concentration of un-ionized ammonia safe to aquatic life in that water can be estimated by multiplying the 96-hour LC_{50} by a determined application factor; but, in general, the maximum permissible in-stream concentration of un-ionized ammonia should be 0.02 mg/l NH_{3-N} for waters classified for fisheries use."

The Colorado Water Quality Control Commission is currently developing new water quality requirements for all state waters. The currently proposed standards recommend an un-ionized ammonia restriction of 0.02 mg/l for all streams which are intended to support aquatic life.

Other Forms of Nitrogen -- The remaining portion of the nitrogen content in raw sewage is largely organic nitrogen, most of which is hydrolized to ammonia prior to and during sewage treatment. Ammonia can be oxidized to nitrate and nitrite by bacterial action. This nitrification process takes place in well-oxygenated bodies of water when ammonia and nitrifying bacteria are present. Such aerobic bacterial conversion requires four units of oxygen for each unit of ammonia which is converted to nitrate. However, this nitrification process occurs very slowly in cold mountain streams and the oxygen used in this biological conversion is continuously balanced by the natural aeration processes which take place within the stream.

Additional pollution problems resulting from this process are related to the fact that nitrates, and nitrites to a lesser extent, are necessary plant nutrients. An increase in the amount of these nutrients can, under certain circumstances, cause an increase in the growth of aquatic plants. Increased plant production may be desirable in relatively unproductive mountain streams, but excessive production can result in eutrophication,

particularly in lakes. At extremely high concentrations, nitrates and nitrites can become toxic to plants and animals, but these levels are seldom reached solely as a result of sewage.

The Colorado Department of Health has studied the dissolved oxygen (DO) content of the Eagle River and several of its tributaries. Their report stated an intent to maintain the normally high level of DO typical of the area and added the DO content should be one of the most important parameters to be used in establishing the required levels of wastewater treatment. Analysis of available data indicated that "dissolved oxygen is not a problem in the basin at this time based on the standard of 6 mg/l ...." Waters of the Eagle River and its tributaries are usually near 100 percent oxygen saturation--a state which varies primarily with water temperature but also with chemical content of the water. The steep gradient and rocky substrate provide excellent aeration of surface waters and help maintain the high levels of dissolved oxygen. The oxygen demand resulting from the oxidation of organic material or conversion of chemical compounds seldom exceeds the re-aeration rate in these cold, turbulent, mountain streams. Extremely heavy waste loading from treatment facilities would be needed to cause a significant decrease in the oxygen content.

Temperature and pH -- In addition to direct effects upon the metabolism of aquatic organisms, temperature and pH are extremely important in controlling the effects of dissolved chemicals on the biota. Temperature and pH may control form, concentration, or general toxicity of certain heavy metals, pesticides, or other chemicals, and may affect the growth of undesirable bacterial contaminants and aquatic plants.

The pH of the streams in the study area occasionally exceed the 9.0 upper limit recommendation for streams of B_1 classification. This elevated level is thought to be a natural phenomenon in many Colorado streams. Groundwater and alluvial water deposits serve as the major source of water to the Eagle River and its tributaries during periods of low flow. These waters are characteristically hard and have a high pH. Stream conditions resulting from such groundwater inflow appear to have no detrimental effect on aquatic life.

Due to the adequate mixing of the study area's streams with the ambient air, temperature extremes have not been a problem in the past and should not be a problem in the future.

Pesticides -- To date, no pesticide pollution problems have been identified in the Eagle River drainage area. Due to the very short growing season (80 days), there is little use of agricultural pesticides. Also, because of the short summer and the cold

nights, few insect pests are encountered in the populated areas which necessitate the use of pesticides. Water quality testing to specifically identify these pollutants has not been carried out.

Heavy Metals -- Analysis of existing data indicates that concentrations of heavy metals are low in surface waters of the study area at points above population centers. Throughout the Gore Creek drainage area, there are relatively low heavy metal concentrations. Water quality analyses of the Eagle River indicate definite heavy metal pollution. The Federal Water Pollution Control Administration (FWPCA) identified three sources of heavy metal discharge into the Eagle River: 1) seepage from the New Jersey Zinc Corporation's old holding pond, 2) direct flow from the New Jersey Zinc Corporation's new holding pond, and 3) drainage from an abandoned mine located on the property of the New Jersey Zinc Corporation, all near the town of Gilman. The primary heavy metal pollutants in the Eagle River are iron, zinc, manganese and copper. Each of these is discussed below.

Most Colorado metal deposits are in the form of complex ore including a mixture of iron, copper, lead, zinc and silver sulfides. Iron sulfide (pyrite) rapidly oxidizes in water, releasing high concentrations of iron and sulfate. These chemicals undergo further oxidation, forming ferric hydroxide (or yellow boy), a yellow precipitate which is commonly found in streams affected by acid mine drainage, and sulfate ions. Yellow boy, in heavy concentrations, can destroy existing benthic fauna and prevent establishment of new benthic organisms. Further, levels of 2,000 ug/l of iron, or above, can be injurious to health. Concentrations of 460 ug/l total iron have been found in Cross Creek, and levels of iron ranging from 310 ug/l to 900 ug/l have been reported in the Eagle River. Deposits of yellow boy (ferric hydroxide) are very evident in the Eagle River, covering much of the substrate from above Minturn to Dowds Junction.

Zinc is the most common toxic heavy metal in Colorado waters. Toxicity of zinc to fish varies considerably with the hardness of water and with the fish species. Chronic exposure of some fish species to sublethal levels of zinc makes them more resistant to normally lethal concentrations that may occur periodically throughout the year. No maximum suggested concentration of zinc has yet been established for Colorado waters. Concentrations of zinc in the Eagle River ranged from 130 ug/l below the drainage from the abandoned mine on the New Jersey Zinc Corporation property, to 310 ug/l two miles downstream from the point of discharge. The high zinc and iron concentration in this area eliminated all bottom organisms. Biological recovery was noted near Dowds Junction.

To date, no manganese standards have been established in Colorado. High levels of manganese have been measured since 1972 in Cross Creek, with no seasonal patterns to correlate with high surface water discharges. Since 1972, all reported levels of manganese

in the Eagle River at the Avon bridge have been below 500 ug/l. Several sampling periods recorded undetectable levels.

The toxicity of copper varies with the chemical composition of the water and species. A maximum permissible level of 500 ug/l has been proposed for the protection of livestock, but no maximum concentration limits have yet been established for Colorado waters to protect aquatic life. EPA has suggested that the maximum allowable copper concentration should be 1/10 of the 96 hour LC_{50} value for the most sensitive species. Although brook and rainbow trout may not prove to be the most sensitive species to copper toxicity, their 96 hour LC_{50} data can be used to arrive at a maximum allowable copper concentration of 10 to 25 ug/l. No detectable copper has been found in Gore Creek or in the Eagle River at the Avon bridge since 1971.

Chlorine Residual -- Chlorine is used widely as a disinfectant in domestic water supply, sewage treatment, public and private swimming pools, and in industry. It serves in many households as a laundry additive. Until recently, the increased aquatic concentrations of chlorine were given little regard, although it has been known for years that chlorine is a potent fish toxicant.

The primary source of chlorine in the surface waters of the study area is the chlorine residual contained in the discharged effluent from the sewage treatment facilities. This residual results primarily from chlorination of the sewage effluent to control bacterial levels. The residual may be found as free available chlorine in the form of hypochlorous acid or hypochlorite ion, but these forms, while strong disinfectants, are highly reactive and are quickly dissipated. In most cases, chlorine in the sewage effluent reacts with certain wastewater constituents to form combined residuals. Reactions with ammonia commonly occur, resulting in mono-, di-, or tri-chloramines. The presence of cyanogen chloride residual is also common in sewage effluent. These combined residuals are as toxic to aquatic organisms as is free chlorine and, when discharged, their low reactivity allows them to remain in solution for long periods of time.

Another form of combined residual chlorine formed during the sewage treatment process are organo-chlorine compounds. These compounds are formed through a complicated reaction between free available chlorine and organic compounds found in domestic sewage and industrial wastes. Recent evidence suggests the carcinogenic (cancer-causing) effect of certain organo-chlorine complexes. To date, only preliminary studies have been conducted on these compounds, thus their toxic effect on aquatic organisms has not been fully evaluated.

Both free available chlorine and combined residual complexes are highly toxic to aquatic life. As with ammonia, the degree of toxicity varies with the relative proportions of other substances in the water. Table 16, on the following page, displays a summary of a portion of the

TABLE 16

TOXICITY EFFECTS OF RESIDUAL CHLORINE ON AQUATIC LIFE
(CONTINUOUS EXPOSURE)

Species	Effect Endpoint	Average Residual Chlorine Concentration (mg/l)
Brook trout	7-day TL50[2]	0.083
Brook trout	Absent in streams	0.015
Brook trout	67% lethality (4 days)	0.01
Brook trout	Depressed activity	0.005
Rainbow trout	96-hr. TL50[2]	0.14-0.29
Rainbow trout	7-day TL50[2]	0.08
Rainbow trout	Lethal (12 days)	0.01
Trout fry	Lethal (2 days)	0.06

[1]SOURCE: All data from: Brungs, W.A., "Effects of Residual Chlorine on Aquatic Life", JWPCF 45 (10), October, 1973. (References for all data are given in this article)

[2]TL50: 50 percent survival in the specified time period

research which has been conducted regarding the toxicity of chlorine residual on cold water fish for continuous exposure periods. Cold water fish are generally considered to be more sensitive to chlorine than warm water species, and W. A. Brungs of the EPA found that trout avoided concentrations as low as 0.001 mg/l. The proposed new Colorado Water Quality Standards require an in-stream maximum level of 0.003 mg/l for protection of aquatic life in cold water streams, and a level of 0.01 mg/l for warm water watercourses.

Data concerning chlorine residual levels in the streams of the Upper Eagle Basin are not available.

Non-Point Pollution

Non-point pollution may be produced by water which has not previously been collected and/or contained, moving over land surfaces and through soils and rock formations, and discharging to surface waters. As this occurs, the mechanisms of erosion, sedimentation, leaching, absorption, dissolution, and precipitation cause various organic and mineral contaminants to be removed from their environment and carried to the receiving stream. This water may originate from irrigation return flow, groundwater sources, or precipitation.

The duration and frequency of precipitation occurrences have major effects on the degree of some types of non-point pollution. Thunderstorms, such as are characteristic of the study area, can cause very high contaminant loadings on streams, but for very short periods.

Agriculture -- Mountain topography and a short growing season limit the farming activity in the study area. Irrigated agriculture occurs along the Eagle River at various locations, from Minturn to Avon, and downstream. Additional agricultural sources of non-point pollution include livestock which may affect stream turbidities by wading or by reducing ground-securing vegetation on and near the stream banks.

Natural Sources -- Natural non-point pollution is that which has always occurred, and is not related to any man-induced activity. Runoff from forested areas may contain some nutrients, but concentrations are likely to be significant only near roads and trails where flow is less restricted. Constructing roads or harvesting timber may cause erosion, resulting in an increased sediment load on surface waters.

Industrial Pollution -- The only major industrial waste discharges to the Eagle River or its tributaries in the study area originates from the mine tailings ponds of the New Jersey Zinc

Corporation near Gilman. The ponds have long been considered to be a source of pollution to the Eagle River, the primary contaminants being ammonia, zinc, iron, manganese, and copper. A Colorado Department of Health report noted that (1) the concentrations of most of these materials in the Eagle River increased significantly in the vicinity of the old tailings pond, and (2) there was a notable reduction in aquatic species and total organism count in the river downstream from the old pond. The report summarized that groundwater seepage from this pond seems to be the primary source of heavy metal contamination in the area. Resultant concentrations of each of these constituents were above the limits proposed for the new Colorado water quality standards in the vicinity of the tailings ponds although concentrations gradually decreased in a downstream direction. Below the Cross Creek confluence, only recommended levels for iron and zinc were exceeded. Below Avon, only the recommended zinc level was exceeded, which was the case as far downstream as the Town of Eagle.

The new pond was also found to discharge ammonia and heavy metals to Cross Creek, but only the ammonia content in Cross Creek had significant effects on the Eagle River. The new pond, and/or other unknown sources at times cause high levels of ammonia in Cross Creek, which when combined with ammonia introduced into the Eagle near the old pond, can cause un-ionized levels greater than 0.02 mg/l to occur. Although it is not suspected that this situation occurs often, the ammonia load near the New Jersey Zinc operation is significant, and should be taken into account in establishing ammonia handling capacities and wasteload allocations for the Eagle River and its tributaries.

Recreation -- The recent rise in popularity of four-wheel and other off-the-road vehicle travel, has presented additional environmental problems, including destruction of soil binding vegetation. Four-wheel drive vehicles also create deep ruts in non-surfaced roads especially when driven with chains in moist soils. During snowmelt or heavy rainy seasons, water flows down these ruts carrying away the loosened soil. Because of the more favorable geography, most roads are located close to streams which receive the muddy runoff.

Ongoing Construction -- The primary water quality problem associated with construction is suspended sediment. Construction equipment can directly increase turbidity in surface waters by traversing the streams or pushing soils into the streams. Increases in turbidity also occur after destruction of vegetation and the loosening of normally compacted soils by construction equipment which result in increased wind and water erosion. Large projects, such as the construction on Interstate 70, must minimize erosion by using specially-designed techniques and equipment.

Winter Road Maintenance -- Winter climate and weather conditions in Eagle County require frequent sanding of highways and community streets. Road salt is mixed with the sand, at a four percent ratio, to prevent sand scattering and to allow the sand to "key" into the ice or snowpack. The State Highway Department applies approximately 3,300 lbs. of salt/sand mixture per mile of highway lane per storm. The salt eventually is dissolved and is carried to water courses by storm runoff and snowmelt water, thus increasing salinity content of these streams.

Urban Runoff Pollution -- Urban runoff is that derived from developed areas, particularly streets, parking lots, and roof tops, and occurs during periods of precipitation and snowmelt. Pollutants contained in urban runoff are similar to those found in municipal sewage, except that concentrations are usually much greater but occur for only short periods.

In the study area, the rare rainfall occurrences are brief and intense, and pollutant loading on water courses may be considerable for very short periods. On the other hand, snowmelt occurs during the warm hours of the day and may last several days or weeks. Also, it should be realized that during the seasons when most precipitation or melting (and urban runoff) occurs, streams tend to be at a high stage and thus are less affected by the pollution load than they would be during periods of low flow.

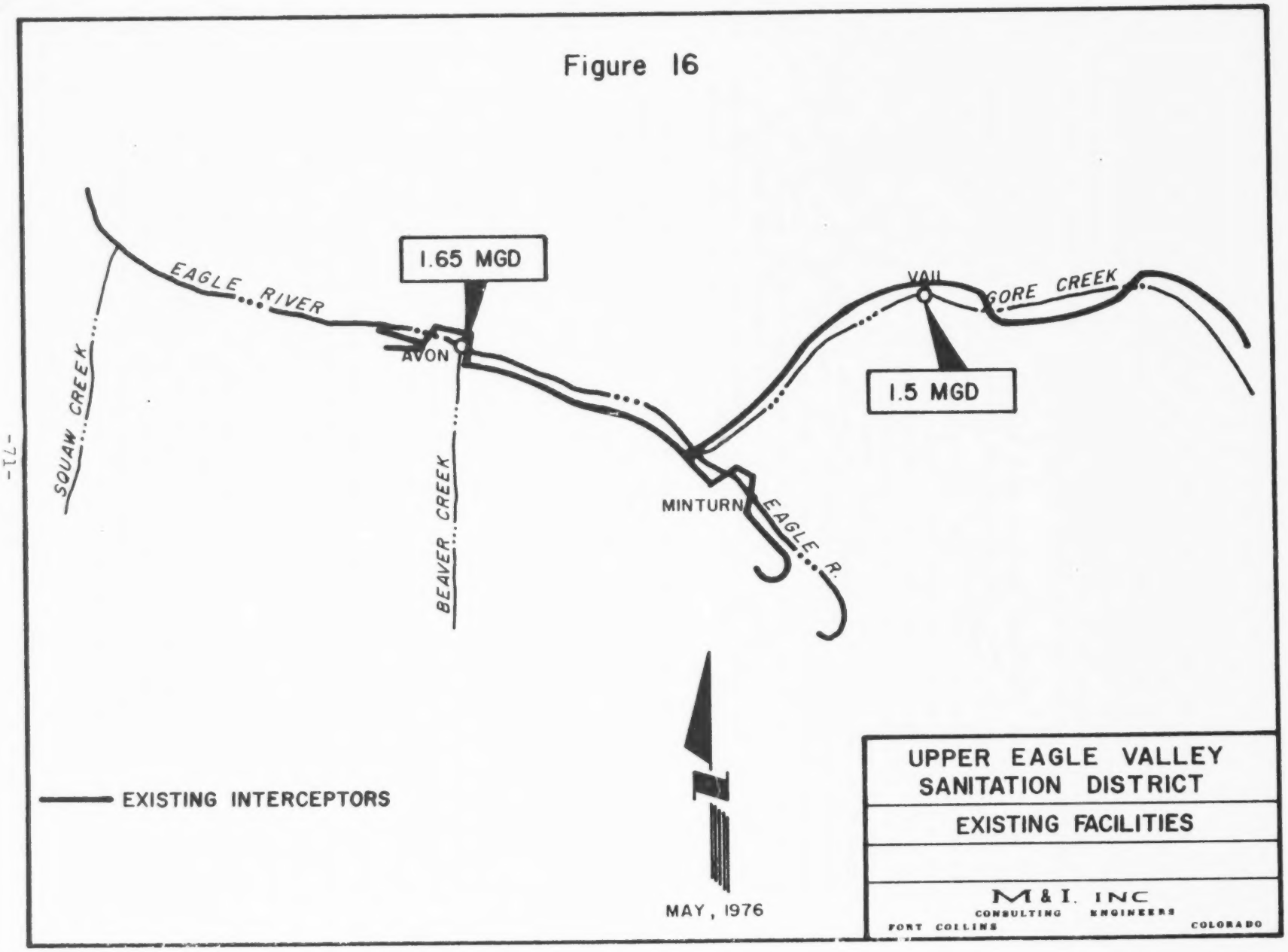
EXISTING FACILITIES AND FLOWS

The sewage treatment plants at Avon, Vail, and Red Cliff currently operate under discharge permits. The location of these facilities is shown in Figure 16. Other facilities located in the study area include the holding ponds of the New Jersey Zinc Corporation and two package aeration plants owned by Vail Associates. (Note that the technical terms utilized in this section are defined in the glossary section.)

Upper Eagle Valley Sanitation District

Description -- The existing wastewater treatment facility for the Upper Eagle Valley Sanitation District (UEVSD) is located at Avon, Colorado. Gravity interceptor lines route raw sewage to the plant from most of the developed areas within the boundaries of the district. Wastewater from the Vail Water and Sanitation District can be diverted into the interceptors for treatment at the Avon plant, and sewage from the Arrowhead subdivision is currently being pumped to the treatment works. The plant usually operates on the conventional activated sludge principle,

Figure 16


EAGLE RIVER
SQUAW CREEK
1.65 MGD
AVON
BEAVER CREEK
MINTURN
EAGLE R.
VAIL
GORE CREEK
1.5 MGD
EXISTING INTERCEPTORS
MAY, 1976
UPPER EAGLE VALLEY
SANITATION DISTRICT
EXISTING FACILITIES
M&I. INC
CONSULTING ENGINEERS
FORT COLLINS
COLORADO

though sometimes the contact-stablilization process is used. Primary clarification is not provided. Following screening and grit removal, the wastewater passes through enclosed aeration and final clarification processes and chlorination prior to discharge to the Eagle River. Secondary sludge receives aerobic digestion and is then dewatered on drying beds. Dried sludge is land-filled or sometimes used in agricultural applications.

The Avon plant original design capacity is two million gallons per day (mgd) but has been evaluated as 1.65 mgd in the engineering portion of the Facilities Plan. The plant usually operates below this capacity, but flows vary substantially on an hourly and seasonal basis, typical for a resort area. The high flows recorded in May through July are attributed largely to infiltration. Occupancy rates are significantly lower during this period, however, stream flows are generally at their highest. These high stream flows cause infiltration to the part of the interceptor system which is located within the stream beds of Gore Creek and the Eagle River. Repairs were made to the interceptor system in 1975-1976, but infiltration was again high during the spring of 1976. In May, 1976, late night flows of 1.22 mgd were recorded at the treatment plant, and sewage strengths were highly diluted. Recorded plant flows for 1975 are given in Table 17, on the following page.

Present performance of the system is evaluated as good; however, because operators are present only 8 to 12 hours per day, sludge return cannot be adjusted for the peak flows. This may allow a buildup of solids and potential solids discharge with the effluent.

Effluent total ammonia concentrations measured at various hours on January 17 through 18, and May 26 through 27, 1976, are shown in Figure 17, following Table 16. The lower May values can be attributed to: (1) weaker influent ammonia concentration due to infiltration, and (2) the occurrence of some nitrification in the treatment processes. The Colorado Department of Health (CDOH) observed plant effluents containing as much as 11 mg/l total ammonia during the winter.

In the Eagle River downstream from the Avon Plant, un-ionized ammonia levels as high as 0.028 mg/l have been recorded, but most documented data indicates that un-ionized ammonia concentrations in this vicinity seldom exceed 0.015 mg/l, and are often considerably less.

Table 18, following Figure 17, displays the estimated average daily ammonia loading which occurred in 1976 during the peak ski season in January and during the winter in general. As can be seen, even during the peak period, loadings for the Avon plant were below maximum allocation levels for the Eagle River. Instream concentrations, resulting from plant discharge, were well below the recommended limits.

TABLE 17

1975 Treated Wastewater Volumes for the Upper Eagle Valley Sanitation District and the Vail Water and Sanitation District[1]

UPPER EAGLE VALLEY SANITATION DISTRICT[4]

Month	Total for Month	Daily Average	High[2] Flow	Low[2] Flow
January	21,883,000	705,903	1,178,000	498,000
February	22,199,000	792,000	909,000	742,000
March	28,509,000	919,645	1,101,000	783,000
April	23,193,000	773,100	1,002,000	651,000
May	28,203,000	909,000	1,171,000	637,000
June	40,301,000	1,343,000	1,594,000	1,117,000
July	39,226,000	1,265,354	1,785,000*	946,000
August	24,699,000	796,741	1,090,000	613,000
September	16,830,000	561,000	687,000	485,000
October	14,080,000	454,193	572,000	375,000*
November	18,956,000	631,866	965,000	432,000
December	20,113,400	648,819	1,002,000	462,000

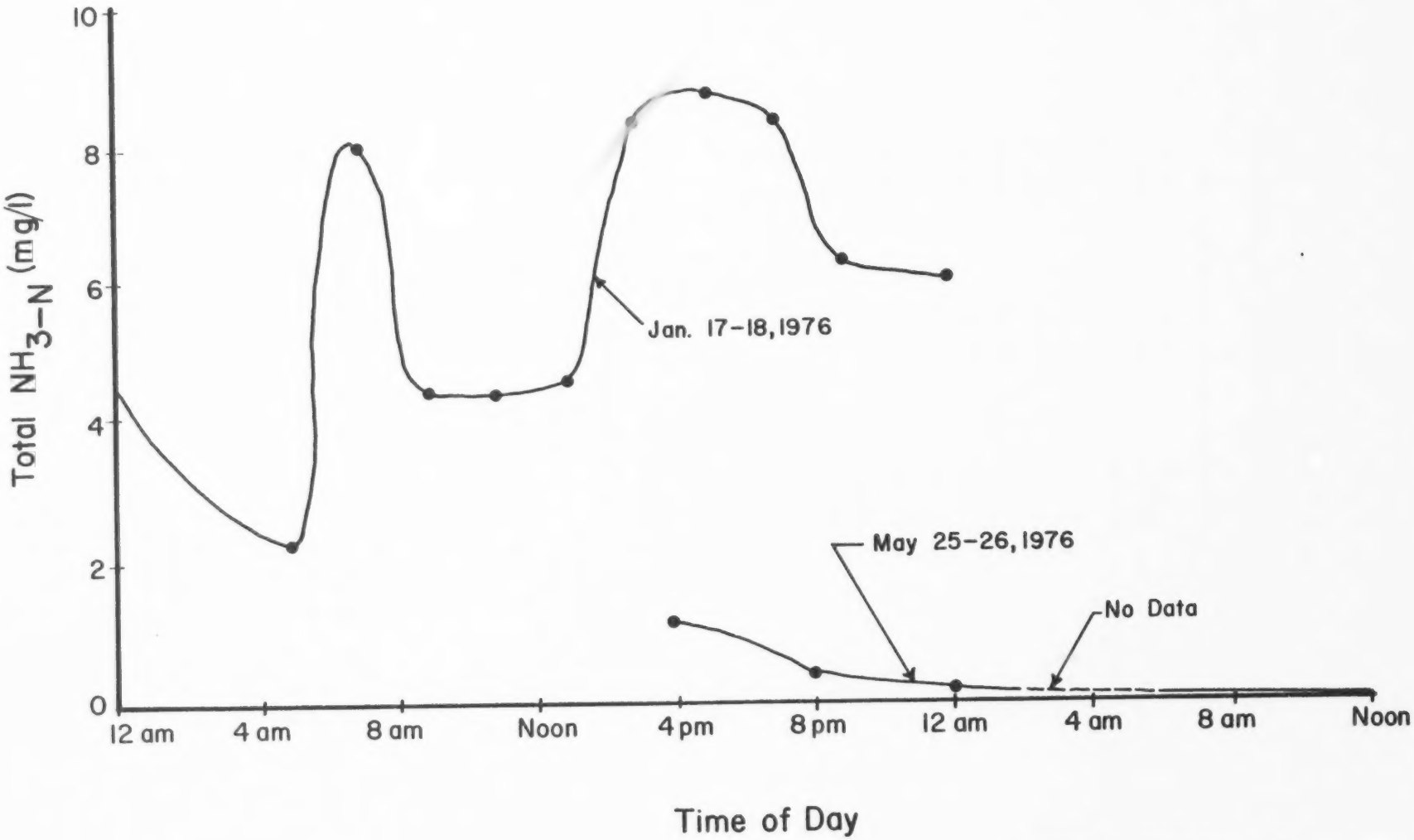
VAIL WATER AND SANITATION DISTRICT[5]

Month	Total for Month	Daily Average	High[2] Flow	Low[2] Flow	Water Production
January	28,276,000	912,129	1,224,000	687,000	32,701,000
February	26,793,000	958,000	1,031,000	847,000	31,407,000
March	30,044,000	969,161	1,133,000	695,000	32,430,000
April	23,002,000	766,733	988,000	594,000	19,434,000
May	21,780,000	702,580	943,000	465,000	15,090,000
June	30,826,000	1,022,533	1,159,000	917,000	19,220,000
July	29,649,000	956,419	1,215,000	741,000	30,647,000
August	27,158,000	876,064	1,121,000	667,000	35,003,000
September	22,667,000	755,566	970,000	609,000	26,073,000
October	18,773,000	604,290	686,000	502,800	15,058,900
November	13,694,000	456,467	1,035,000	105,000*	3
December	27,458,000	885,742	1,295,000*	558,000	26,966,700

1 Based on records of each district, flows in gal. per day
2 Maximum or minimum daily flow recorded for the month
3 Volume unknown
4 Values are 15 percent low due to error in plant metering device
5 Values are 40 percent low due to error in plant metering device
* Underlined values represent the maximum or minimum daily flow recorded for the year

Figure 17

UPPER EAGLE VALLEY SANITATION DISTRICT
EFFLUENT AMMONIA CHARACTERISTICS



SOURCE: M&I Inc., 1976

TABLE 18

ESTIMATED AMMONIA LOADING IN 1976 - AVON PLANT

Flow Conditions		Daily Plant Flow (mgd)	Total Ammonia Discharged (lb/day)[2]	Dec. - July Wasteload Allocation (lb/day)[1]	Resulting Stream Total Ammonia Con. (mg/l)[3] (average)	Total Steam Ammonia Allowed to Maintain Un-ionized Con. Less than 0.02 mg/l (mg/l)[4]
Peak Ski Season, 1976	Eagle River	1.20[2]	106	245	0.48[6]	1.27[4]/3.97[5]
Normal Winter Flows, 1976	Eagle River	0.9	80	245	0.38[4]	1.27[4]

NOTES:

[1]From NHPZ, 1975

[2]Based on flow and ammonia measurements made at plants in January, 1976

[3]Does not include any background ammonia present, or effects of other sources (N. J. Zinc)

[4]Based on historic 7-day/10 year low flows, pH, and temperature which create the most adverse loading conditions for winter

[5]Based on historic 7-day/10 year low flows, pH, and temperature for January (N.H.P.Q., 1975)

[6]Based on historic 7-day/10 year low flows for January

[7]Based on 1975 flow data corrected for metering error

SOURCE: CDM Inc., M & I Inc., NHPQ (1975)

Permit Requirements -- The requirements of the UEVSD Discharge Permit are shown in Appendix L . Of particular note are the ammonia restrictions which were taken directly from wasteload allocation determined in a report entitled Population Capacity of the Eagle Valley Based on Ammonia Toxicity prepared for Vail Associates. The ammonia wasteload allocations are based on a maximum allowable in-stream concentration for un-ionized ammonia of 0.02 mg/l.

Vail Water and Sanitation District

Description -- The Vail Water and Sanitation District Wastewater Treatment Plant is located near the west boundary of the town of Vail and discharges to Gore Creek. The facility normally treats all sewage for Vail, but during the ski season, if peak loads would cause the plant's capacity to be exceeded, the excess flow can be bypassed downstream through UEVSD interceptors to the Avon plant. Sewage originating in the Bighorn community, although a part of the Upper Eagle Valley Sanitation District, is frequently treated at the Vail facility.

The facility is an activated sludge plant, operating on the conventional or contact-stabilization principle. Following screening and grit removal, sewage passes directly to aeration, followed by final clarification, chlorination, and discharge to Gore Creek. Primary clarification is not provided. Waste sludge is thickened by flotation, dewatered with vacuum filtration and hauled to a landfill site.

Performance -- The rated capacity of the Vail plant is 1.5 mgd, and, according to the district records (as shown in Table 19 on the following page), this flow was not exceeded on a daily basis in 1975. However, the flow measuring device has been found to be in error, and the actual plant flows are estimated to have been 40 percent greater than those recorded. The plant design capacity was therefore exceeded during portions of January and December, 1975. Average daily flows as high as 2.75 mgd were measured in January of 1976. Highly variable hourly flows have often exceeded plant capacity during certain times of the day, particularly during the ski season. Flows vary considerably on a seasonal basis, but a considerable portion of spring and summer flows are due to infiltration. In May, 1976, night-time flows as great as 1.28 mgd were observed, indicating severe infiltration. Sewage strengths were also extremely low.

The Vail treatment plant also is staffed only eight hours per day (12 hours during ski season). The high peak flows occurring in the evening have, in the past, caused periodic solids build-up in the tanks and occasional discharge of these solids with the effluent. Effluent total ammonia levels measured periodically on

TABLE 19

ESTIMATED AMMONIA LOADING IN 1976 - VAIL PLANT

Flow Conditions	Discharge Point	Daily Plant Flow (mgd)	Total Ammonia Discharged (lb/day)[1]	Resulting Stream Total Ammonia Con. (mg/l)[2] (average)	Total Steam Ammonia Allowed to Maintain Un-ionized Con. Less than 0.02 mg/l (mg/l)[3]
Peak Ski Season, 1976	Gore Creek	2.75[1]	177	2.67[5]	0.93[3]/3.16[4]
Normal Winter Flows, 1976[6]	Gore Creek	1.4	99	1.32[3]	.93[3]

NOTES: [1]Based on flow and ammonia measurements made at plants in January, 1976

[2]Does not include any background ammonia present, or effects of other sources (N. J. Zinc)

[3]Based on historic 7-day/10-year low flows, pH, and temperature which create the most adverse loading conditions for winter

[4]Based on historic 7-day/10 year low flows, pH and temperature for January (N.H.P.Q., 1975)

[5]Based on historic 7-day/10 year low flows for January

[6]Based on 1975 flow data corrected for metering error

SOURCE: CDM Inc., M & I Inc., NHPQ (1975)

January 17 through 18 and May 25 through 26 are shown in Figure 18 on the following page. As was characteristic of the Avon plant, the May values are much lower than those for January, which again is attributed to extremely low influent ammonia concentrations caused by low wastewater flow and high infiltration, and the occurrence of nitrification in the treatment processes. The data indicated that no in-plant nitrification occurred during the January 17-18 sampling period. Total ammonia levels in the range of 12 to 21 mg/l in the Vail plant effluent were measured in February, 1975, and also measured 7.2 mg/l in April of that year.

Due to the high ammonia levels discharged from the Vail plant during certain times of the year, and the relatively low capacity of Gore Creek to accept these discharges, high levels of un-ionized ammonia are attained in Gore Creek downstream from the plant discharge point. During February, 1975, un-ionized levels as high as .07 mg/l were measured (average values were greater than .04 mg/l). The Colorado Department of Health has also measured un-ionized ammonia levels as high as .049 mg/l in Gore Creek at its confluence with the Eagle River.

Winter low flow months are the most critical time periods regarding ammonia toxicity, since the highest levels are observed at this time. During warmer periods, ammonia is more toxic, but in the past, lower sewage loads, higher streamflow, and in-plant nitrification have resulted in a much lower ammonia content in Gore Creek in the spring and summer.

Table 19 also gives the estimated average ammonia loading which occurred in 1976 during the peak ski season in January and during the winter in general.

Based on research of the toxic effects of residual chlorine on trout, an in-stream maximum allowable level of 0.003 mg/l is currently being considered for adoption by the CDOH. Chlorine residual discharge at the Vail plant in accordance with the present permit (0.5 mg/l) will probably cause the recommended in-stream limit to be exceeded much of the year, particularly in the winter.

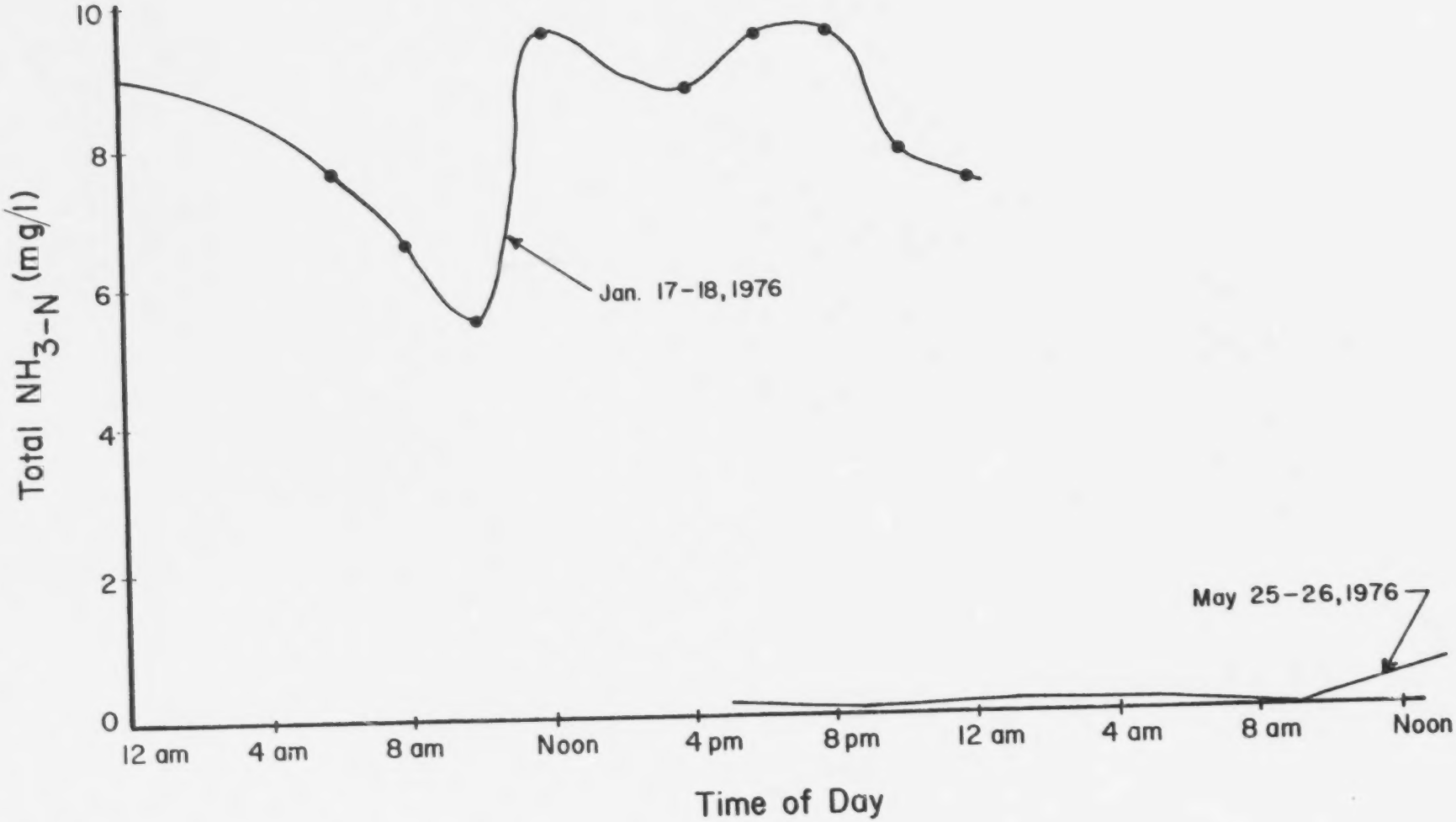
Permit -- The stipulations of the Vail Water and Sanitation District Discharge Permit are shown in Appendix L . No stipulation for ammonia was included in the new permit, which was issued late in 1976.

Red Cliff Water and Sanitation District

Description -- The Red Cliff Water and Sanitation District sewage treatment facility is located at the confluence of the Eagle River

Figure 18

VAIL WATER AND SANITATION DISTRICT
EFFLUENT AMMONIA CHARACTERISTICS



SOURCE: M & T Inc., 1976

and Homestake Creek. The plant and the collection system were completed in 1972. The plant is an open package type operating on the contact-stabilization process. The unit includes a manual bar screen, contact tank, stabilization tank, a final clarifier, chlorine contact chamber, and an aerobic digestion tank. Drying beds are provided for sludge dewatering.

Performance -- The existing collection lines, while only four years old, are subject to severe infiltration/inflow problems. It has been estimated that raw sewage accounts for only about 20 percent of the total flow in the collection system.

Infiltration has been attributed to substandard sewer construction and inadequate inspection. The alluvial soil is rocky and has a high water table. Although concrete pipe was specified, clay pipe was used. The amount of infiltration allowed by the CDOH is currently exceeded by more than 20 times in July. In winter water service lines are bled to the sewer system to prevent line freezing, and this volume equals the summer infiltration flow.

The Red Cliff package treatment plant is designed to treat .07 mgd, but due to infiltration/inflow in the sewers, plant flows are consistently three to five times this amount. Due to this high hydraulic loading, the plant is not able to operate properly, and much of the "reduction" in pollutant concentrations from raw sewage can be attributed only to dilution.

Since adequate biological oxidation and assimilation reactions do not take place within the plant, the organic and suspended solids content in the sewage are not actually removed. Consequently, much of the time, raw sewage is discharged, in diluted form, to the Eagle River. If the hydraulic loading problem is corrected, the plant would still be inadequate, because the unit is not covered or otherwise protected, chlorine contact time is inadequate, and the aerobic digester cannot provide sufficient volatiles reduction. No provision has been made for sludge disposal in the winter. Aeration capacity is inadequate and treatment cannot be isolated without shutting down the entire process. The plant was not designed with either safety considerations or access to equipment in mind.

Permit -- The stipulations of the discharge permit are included in Appendix L . This permit expired in September, 1976, and the new permit is not expected to be significantly more restrictive.

Other Facilities

Description -- The NJZ Corp. maintains two tailings ponds, referred to as the old and the new pond. The new pond discharges directly to Cross Creek through a series of outlet works and a channel. Sewage from the town of Gilman is passed through septic tanks and chlorinated. It is then mixed with mine tailings in the pipeline, en route to the new pond.

The old pond no longer receives waste material, but lime is mixed with seepage water from this pond, and the slurry is pumped through the tailings pipeline en route to the new pond. The lime is used to raise the pH of the tailing waste to facilitate precipitation of metals and enhance settling. (Residence time in the pond is two to three days and the average inflow rate is 1700 gallons per minute when the mill is in operation.) The tailings wastes and Gilman sewage receive no further treatment prior to discharge to Cross Creek.

Performance -- The new pond discharges highly variable amounts of iron, manganese, lead, zinc, and ammonia to Cross Creek, yet only manganese and ammonia levels increased significantly in the stream, and the ammonia increases were not consistent. In one measurement, the ammonia level was already at a high value upstream from the discharge point. The total ammonia contributed either by the pond or unknown upstream sources was, in some cases, great enough to cause un-ionized levels in excess of 0.02 mg/l to occur in Cross Creek, and when combined with ammonia introduced into the Eagle River near the old pond, excessive un-ionized levels also occurred in the Eagle River.

Un-ionized ammonia levels in excess of 0.02 mg/l in Cross Creek and the Eagle River have been verified by the Colorado Department of Health. Any increases in metal content in the Eagle River beyond the Cross Creek confluence were mostly minor, and in many cases, the amounts decreased, probably due to dilution. Total organism counts have been shown to increase in the Eagle River beyond its confluence with Cross Creek.

Measured data demonstrated that the NJZ Corp. at times, but not consistently, exceeds its discharge permit limitations for copper, iron, and manganese. In the Eagle River, concentrations of iron and zinc were consistently above the recommended levels of the proposed Colorado Water Quality Standards, both upstream and downstream of the Cross Creek confluence, indicating that the primary source was upstream from Cross Creek. Therefore any increases in iron and zinc concentrations in Cross Creek caused by discharge from the new pond were minor.

Permit -- The discharge permit for the new tailings pond expires July, 1978. The discharge requirements of the permit are shown

in Appendix L. The NJZ Corp. has recently been issued a second permit for a controlled groundwater discharge from a mine. The discharge point is on Turkey Creek upstream from Red Cliff. No treatment is provided to the discharged liquid, which contains no tailings, excessive metals, or other waste material.

The only other sewage treatment facilities upstream from the study area are two package aeration plants located on Vail Mountain, one at the Mid-Vail Restaurant and another at the Lionshead Restaurant in the Eagles Nest Area. Both are owned and operated by Vail Associates, and both are non-discharging. Disposal is accomplished through leaching and percolation.

II. THE ALTERNATIVES AND THE PROPOSED ACTION

The purposes of this chapter are to:

- Present the alternatives evaluation process and the integration of both the engineering and environmental analyses
- Discuss each of the four alternatives selected for further environmental analysis
- Describe the process by which the final selection was made

THE ALTERNATIVES EVALUATION PROCESS

A 201 Facilities Plan has the multiple goals of:

- Identification of future wastewater facility demands/needs for a 20 year planning period
- Preparation of an environmental analysis which, first, sets criteria for the selection of alternative treatment methods and treatment plant configurations/sizes and, second, analyzes and compares the impacts of various selected alternatives
- Integration of engineering and environmental analyses to ensure full consideration of environmental and cost/technological issues

Engineering and Environmental Integration

In the 201 planning process, when the EIS and facilities plan are performed concurrently, it is referred to as a "piggyback" EIS approach. The purpose is to bring environmental issues to the forefront during early stages of the decision-making process.

During the initial stage of the Upper Eagle Valley facilities planning process, environmental data was collected and analyzed, including population and land use projections, geology and soils, biological inventories, and hydrologic and water quality data. These data revealed the environmental hazard areas (snow avalanches, 100 year floodplain, debris fans, rockfall areas) as well as environmentally sensitive areas (culturally significant, densely populated, natural riparian vegetation, and wildlife migration areas) which should be avoided or protected during the construction and operation stage of treatment facilities and pipelines.

Each facet of the area's existing environment (and future environment in the case of population/land use/air quality) was described

in order to ascertain the engineering constraints. The environmental aspects were given consideration through:

- Presentation and discussion at public 201 Advisory Committee and combined Sanitation District Meetings. Major topics included population and land use, treatment processes, water quality and ammonia standards, and infiltration and system renovation.

- Roundtable discussions, attended by both the environmental and technical personnel preparing each analysis. Major considerations were: evaluation of present plant sites for future expansion; analysis of equipment and procedures presently used, in terms of adequacy; distribution of future population; treatment processes, and sludge disposal methods, including land treatment of either sludge or effluent; and consideration of alternative sites, for future plants.

The outcome of the initial discussions resulted in the ten alternatives shown in Table 20, on the following page. These were then presented to the following groups:

- The 201 Advisory Committee
- Vail Water and Sanitation and Upper Eagle Valley Sanitation Boards; Minturn Town Manager; and representatives of the Red Cliff Water and Sanitation District
- The public, at a formally announced "Public Hearing"

The sizing and locational alternatives were discussed at length. The ten alternatives were discussed and evaluated, and some solutions were discarded, while others were combined. The result was the set of four alternatives and three subalternatives discussed in the following section.

DESCRIPTION OF ALTERNATIVES

Selection of the sewage system improvements which will adequately meet the needs of the projected population growth required consideration of various alternatives for plant siting, plant sizing, and the need and location of new and/or enlarged interceptors. In addition, various treatment processes were investigated to determine which was the most economical and flexible. This section describes the facilities and process alternatives which were selected for in-depth environmental analysis, and from which the preferred alternative was selected.

Alternatives were evaluated for the Upper Eagle Valley Sanitation District and the Vail Water and Sanitation District.

TABLE 20

201 FACILITIES PLAN ALTERNATIVES

Designation Prior To Final Selection	Description	Evaulation	New Designation For Final Evaluation
Alternative 1	No expansion or upgrading of area treatment works. "No project" alternative.	Although impractical, this"solution" must be considered according to NEPA guidelines.	Alternative 5
Alternative 2	Abandon Vail and Avon plants. Construct a new 6.2 mgd plant now to meet 1985 demands, and expand to 8.8 mgd in 1985 to meet 1995 projected demands.	Not cost effective in that present treatment works are not antiquated and may be expanded and upgraded more economically.	Eliminated from further consideration.
Alternative 3a	Upgrade Vail at present capacity. Construct new 2.6 mgd plant at Dowds Junction. Expand and upgrade Avon Plant now to 2.5 mgd (1985 flows) and in 1985 to 4.7 (1995 flows).	An acceptable, cost effective alternative. Selected for further evaluation.	Alternative 1
Alternative 3b	Abandon Vail. Construct new 4.1 mgd plant at Dowds Junction. Expand and upgrade Avon Plant now to 2.5 mgd (1985 flows) and to 4.7 mgd in 1985 to meet 1995 flows.	An acceptable, cost effective alternative. Selected for further evaluation.	Alternative 2
Alternative 4	Expand and upgrade Vail now to 3.0 mgd with flow equalization. Expand and upgrade Avon now to 3.5 mgd (1985 flows) and to 5.8 mgd in 1985 to meet 1995 flows.	An acceptable, cost effective solution. This alternative has the advantage of leaving several options open in 1985 to meet 1995 needs (discussed below).	Alternative 3a
Alternative 5	Expand and upgrade Vail to 3.0 mgd with flow equalization. Expand and upgrade Avon plant to 3.5 mgd. Construct new 2.3 mgd plant in 1985 at downstream site (1995 flows).	This alternative is viable. The only difference between this and the prior alternative is expansion of Avon vs. a new downstream plant. Thus, an option may be left open.	Alternative 3b
Alternative 6	Same as Alternative 4 except detention time at Vail decreased. No bypass to Avon Plant.	Evaluated as a sub-alternative, not a true alternative.	Alternative 3c
Alternative 7	Same as Alternative 5 except detention time at Vail decreased. No bypass to Avon Plant.	Evaluation as a sub-alternative, not a true alternative.	Alternative 3d
Alternative 8	This alternative was included to allow for the withdrawal of Vail from the 201 plan if desired.- No expansion of Vail. East Vail flow bypassed to Avon. Upgrade and expand Avon to 3.5 mgd (1985 flows). Construct 2.3 mgd plant in 1985 downstream to meet 1995 flows or expand Avon facility in 1985 to meet 1995 flows.	Evaluated as practical at the time of the hearings. Questions of equity and financing might have caused Vail to withdraw from the 201 area.	Alternative 4
Alternative 9	Construct a 8.8 mgd land treatment facility now to meet 1995 flows.	Not cost effective. Storage and transportation problems and short growing season.	Eliminated from further consideration
Alternative 10	Expand and upgrade Vail to 3.0 mgd with flow equalization of bypass. Construct a 5.8 mgd land treatment facility now at a downstream site, to meet 1995 flows.	Not cost effective. The plant may be too large if growth does not occur. Storage problems.	Eliminated from further consideration

Most of the alternatives involved a coordinated effort between the two districts, since their sewage treatment works are physically connected. Alternatives were not considered for Red Cliff since previously recommended improvements were evaluated and were considered as part of the 201 facilities plan. They are discussed and evaluated in Appendix N.

Initially, a variety of siting and sizing options were evaluated. The evaluation and selection process resulted in an elimination to the most feasible ten alternatives. These original ten alternatives were presented, evaluated and discussed. Following these meetings, input from local, state, and federal officials and the general public was received, and the ten were combined or eliminated. The final selection of four alternatives, and three subalternatives, is discussed below. The alternatives have two components: (1) upgrading and expanding existing plants and/or constructing new facilities and interceptors, and (2) replacing portions of the existing interceptor (pipeline) system in order to increase overall flow capacity. Interceptor replacement generally consists of removing existing pipe and installing new pipe of larger diameter, as required for the projected flows, at the same grade and alignment. Parallel rather than new sewer lines may be used in some locations, but replacement of existing pipe at the same location minimizes the need for additional space and easements. A "no-project" alternative has been included, because its consideration is required by NEPA guidelines. A no-funding alternative is evaluated as part of the chapter on Institutional and Financial Considerations and Impacts.

Alternative 1

The Vail plant would remain at its present capacity (1.5 mgd), but would be upgraded to comply with discharge standards. All sewage flows generated in Vail and Bighorn in excess of 1.5 mgd would then be treated at a downstream location. Sludge handling equipment would be removed, and waste activated sludge conveyed downstream with the bypassed raw sewage through the interceptor lines. A new 2.6 mgd plant would be immediately constructed between Vail and Avon, at Dowds Junction, with effluent discharge to the Eagle River. This facility would have ammonia removal capability, and all waste sludge would be conveyed to the Avon plant. The new Dowds Junction plant would be designed to treat all sewage generated to the year 1995 in the Gore Creek drainage, except for that treated at the Vail plant. Since most of the projected Gore Valley growth will take place by 1985, staging is not practicable.

The Avon facility would be expanded to 2.5 mgd immediately, and to 4.7 mgd in 1985. It would treat all sewage originating in the upper Eagle drainage, excluding Gore Creek, and including waste sludge from the Dowds Junction plant. The plant would

have ammonia removal, flow equalization, and sludge handling and disposal facilities.

Alternative 1 would require extensive interceptor replacement, particularly in the Gore Creek drainage below Vail (only 1.5 mgd would be retained at Vail with all other flows, including hourly peaks, bypassed downstream). Some interceptor segments between Dowds Junction and Avon as well as in the Vail and Bighorn areas would also require replacement. Total distance of new lines for this alternative is 13.12 kilometers (8.15 miles). Alternative 1 is shown in Figure 19, on the following page.

Alternative 2

In this alternative, the Vail facility would be abandoned as soon as a new plant is completed, between Vail and Avon at Dowds Junction, The plant design capacity would be 4.1 mgd, and would provide treatment for 1995 flows from the entire Gore Creek drainage area (Bighorn, Vail, and West Vail). As with Alternative 1, staging would not be desirable since 1995 populations in the Gore valley are projected to be only slightly higher than in 1985. Ammonia removal would be provided, and all waste sludge returned to the interceptor system for conveyance to the Avon plant.

The Avon plant would be expanded to 2.5 mgd by 1985 and to 4.7 by 1995. It would be sized, staged, and provided with ammonia removal, flow equalization, and sludge facilities (as in Alternative 1).

Interceptor replacement would include that required for Alternative 1, with the additional replacement of lines from the Vail plant downstream to the new plant. Total length of replacements is 13.66 kilometers (8.49 miles). For all alternatives, new interceptor replacements would be carried out immediately and designed for 1995 flows. Alternative 2 is shown in Figure 20, following Figure 19.

Alternative 3

This alternative would involve immediate expansion of the Vail plant to 3 mgd, to treat 1995 flows from Vail as well as Bighorn. The plant could either be designed to treat the peak flows that occur during the ski season, Alternative 3c,d, or peak flows could be equalized and/or bypassed downstream to the Avon plant, Alternative 3a,b. Ammonia removal would be provided at the Vail plant, and all waste sludge would be returned to the interceptor system for conveyance to the Avon facility.

Figure 19

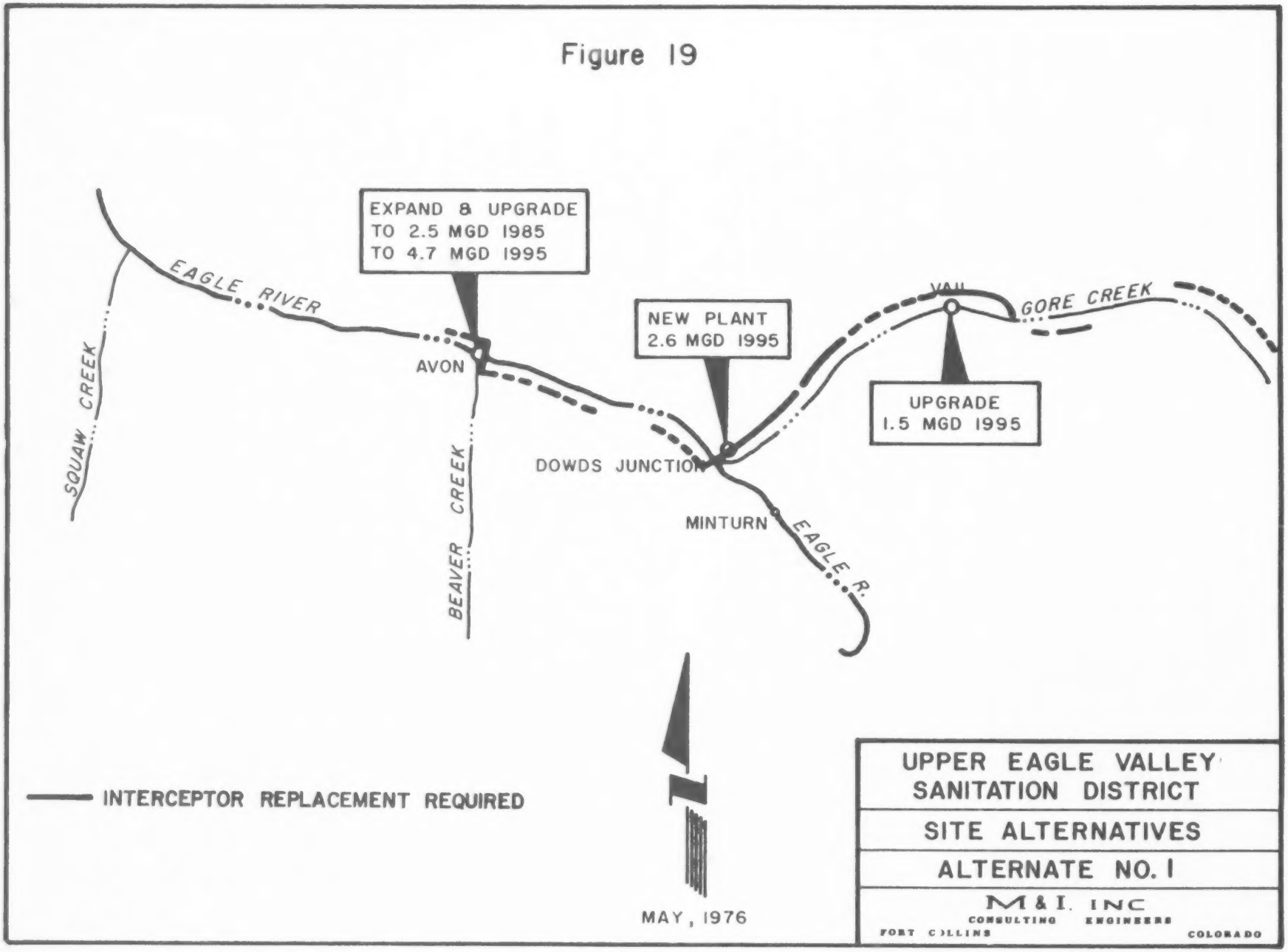
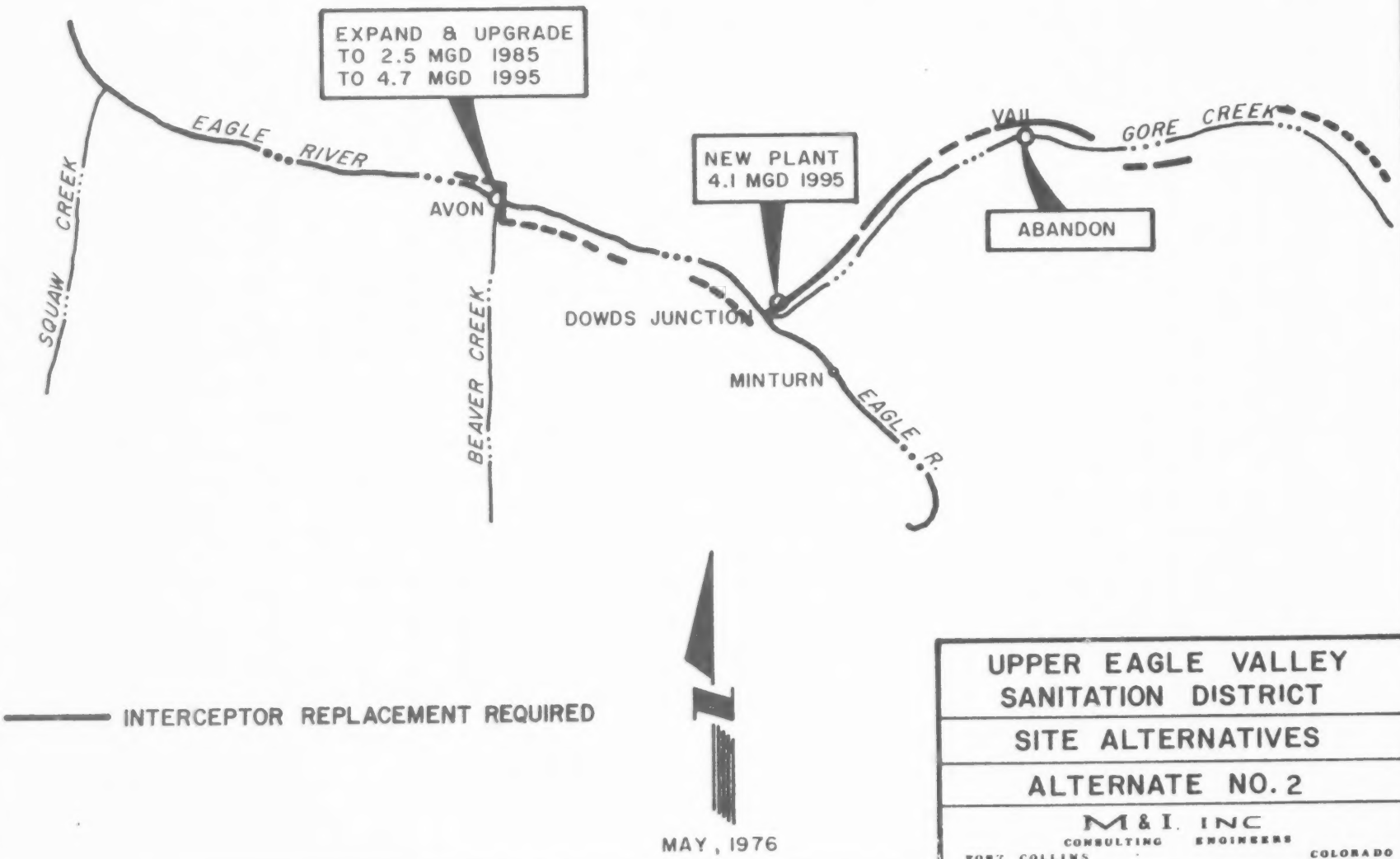

EXPAND & UPGRADE
TO 2.5 MGD 1985
TO 4.7 MGD 1995
NEW PLANT
2.6 MGD 1995
UPGRADE
1.5 MGD 1995
EAGLE RIVER
SQUAW CREEK
BEAVER CREEK
AVON
DOWDS JUNCTION
MINTURN
EAGLE R.
VAIL
GORE CREEK
INTERCEPTOR REPLACEMENT REQUIRED
MAY, 1976
UPPER EAGLE VALLEY
SANITATION DISTRICT
SITE ALTERNATIVES
ALTERNATE NO. 1
M&I. INC
CONSULTING ENGINEERS
FORT COLLINS
COLORADO

Figure 20


EXPAND & UPGRADE
TO 2.5 MGD 1985
TO 4.7 MGD 1995
NEW PLANT
4.1 MGD 1995
ABANDON
EAGLE RIVER
SQUAW CREEK
BEAVER CREEK
AVON
DOWDS JUNCTION
MINTURN
EAGLE R.
VAIL
GORE CREEK
INTERCEPTOR REPLACEMENT REQUIRED
MAY, 1976
UPPER EAGLE VALLEY
SANITATION DISTRICT
SITE ALTERNATIVES
ALTERNATE NO. 2
M & I. INC
CONSULTING ENGINEERS
FORT COLLINS
COLORADO

The Avon plant would be immediately expanded to 3.5 mgd to treat all sewage generated downstream from the Vail plant through 1985. It would provide ammonia removal, flow equalization, and sludge handling and disposal. To meet the projected flows from the same tributary area to the year 1995, the Avon plant would be expanded in 1985 to a capacity of 5.8 mgd. As an alternative to the 1985 expansion, a new plant could be constructed downstream in the vicinity of the Squaw Creek confluence. The facility would be designed for a flow of 2.3 mgd plus any additional identified flows for any new development between Avon and Squaw Creek. Equalization for peak flows would be provided at the Avon plant, and the new plant would also have ammonia removal and sludge handling and disposal facilities. The decision to either enlarge the Avon facility or build a new plant should be made later, when the expansion becomes necessary. For simplicity, the various options offered with this alternative are summarized into four subalternatives:

Alternative 3a: Design to bypass peak flows at the Vail plant, and enlarge the Avon plant in 1985.

Alternative 3b: Design to bypass peak flows at the Vail plant, and construct a downstream plant in 1985.

Alternative 3c: Design the Vail plant to treat peak flows, and enlarge the Avon plant in 1985.

Alternative 3d: Design the Vail plant to treat peak flows, and construct a downstream plant in 1985.

Interceptor replacements for 3a and 3c would be less than with either Alternative 1 or 2, since more sewage is treated at upstream locations. A completely new interceptor would be needed downstream for Alternatives 3b and 3d from Avon to the new plant. The total new interceptor requirements for 1995 would be:

Alternative 3a: 8.45 kilometers (5.25 miles)

Alternative 3b: 18.57 kilometers (11.54 miles)

Alternative 3c: 9.98 kilometers (5.58 miles)

Alternative 3d: 18.12 kilometers (11.26 miles)

The approximate placement of these interceptor lines is depicted on Figures 21 and 22, on the following pages.

Alternative 4

This alternative would provide for improvement and expansion of sewage facilities in the Upper Eagle Valley Sanitation District

Figure 21

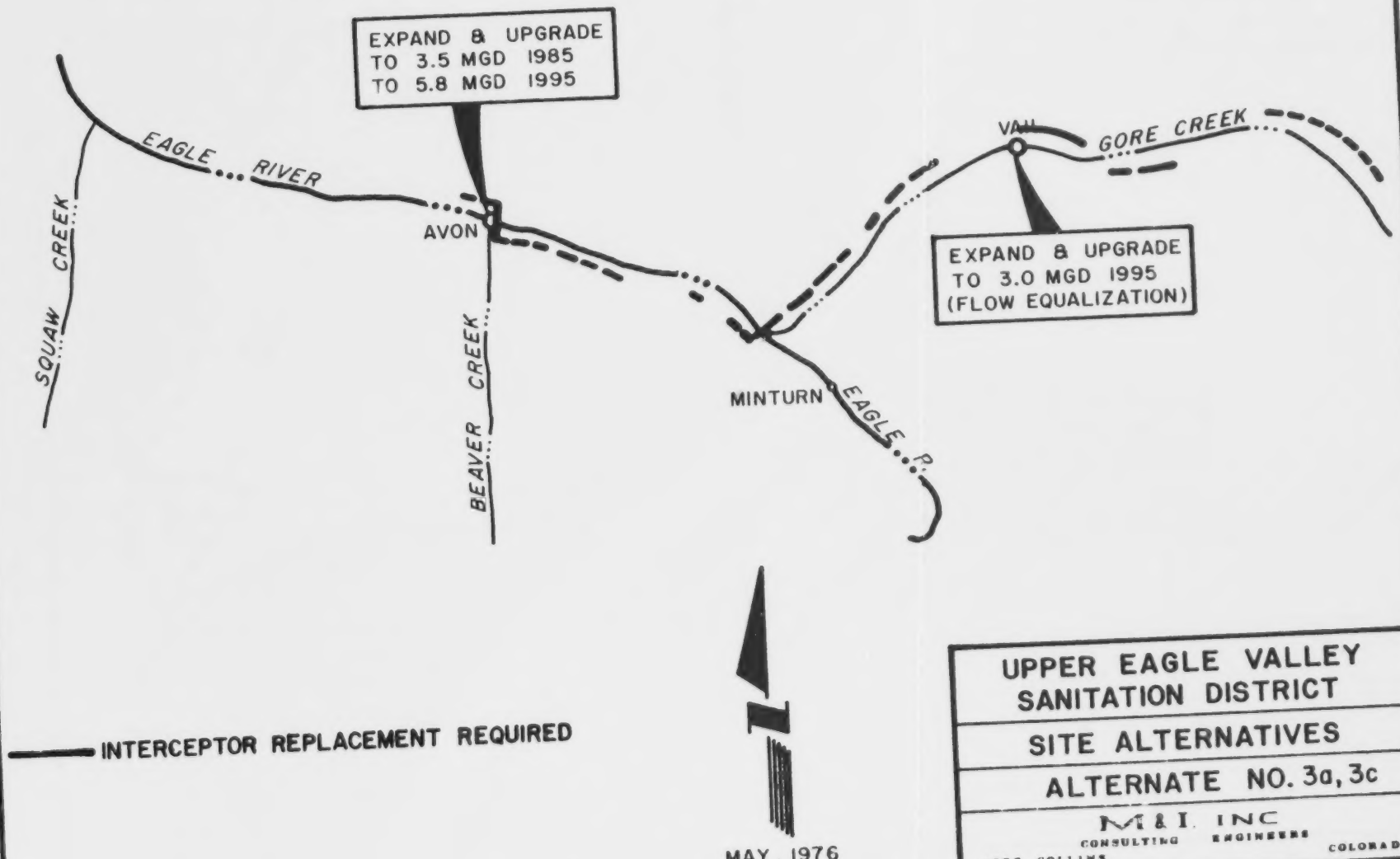
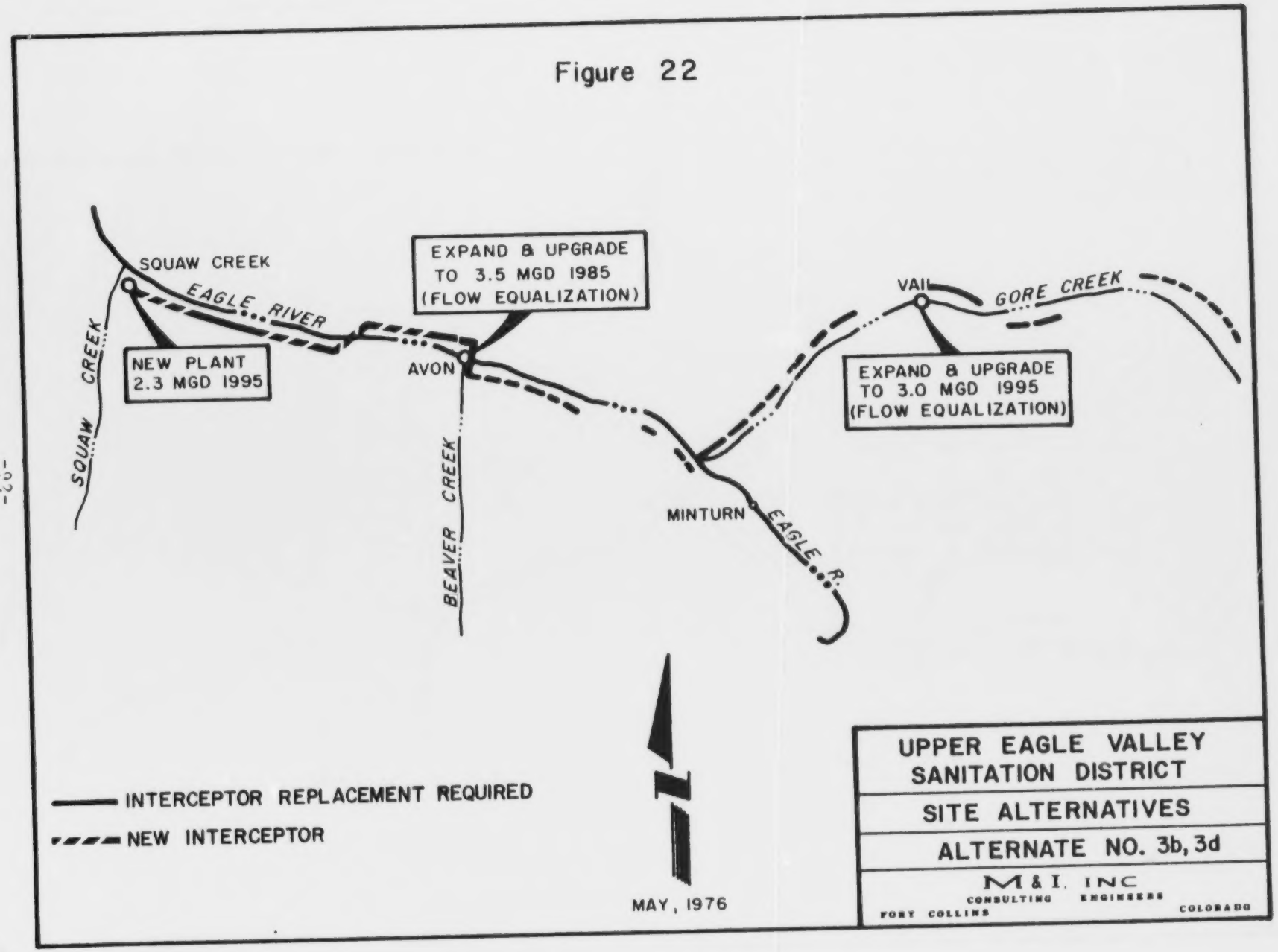

EXPAND & UPGRADE
TO 3.5 MGD 1985
TO 5.8 MGD 1995
EAGLE RIVER
SQUAW CREEK
AVON
BEAVER CREEK
MINTURN
EAGLE R.
VAIL
GORE CREEK
EXPAND & UPGRADE
TO 3.0 MGD 1995
(FLOW EQUALIZATION)
INTERCEPTOR REPLACEMENT REQUIRED
MAY, 1976
UPPER EAGLE VALLEY
SANITATION DISTRICT
SITE ALTERNATIVES
ALTERNATE NO. 3a, 3c
M&I INC
CONSULTING ENGINEERS
FORT COLLINS COLORADO

Figure 22


SQUAW CREEK
EAGLE RIVER
SQUAW CREEK
NEW PLANT
2.3 MGD 1995
EXPAND & UPGRADE
TO 3.5 MGD 1985
(FLOW EQUALIZATION)
AVON
BEAVER CREEK
MINTURN
EAGLE R.
VAIL
GORE CREEK
EXPAND & UPGRADE
TO 3.0 MGD 1995
(FLOW EQUALIZATION)
INTERCEPTOR REPLACEMENT REQUIRED
NEW INTERCEPTOR
MAY, 1976
UPPER EAGLE VALLEY
SANITATION DISTRICT
SITE ALTERNATIVES
ALTERNATE NO. 3b, 3d
M & I. INC
CONSULTING ENGINEERS
FORT COLLINS
COLORADO

only. Its intent is to allow the Vail Water and Sanitation District, should it so elect, to pursue an individual course of action under its own schedule, remaining separate from the UEVSD. Bighorn's sewage flows would be bypassed around the Vail plant, and routed to the Avon plant.

The Avon plant would be immediately expanded to 3.5 mgd to accomodate the 1985 projected flows. Ammonia removal, flow equalization, and sludge handling and disposal would be provided. In 1985, the Avon plant could be expanded or a new plant could be constructed at a downstream site near Squaw Creek. The plant would be designed for a flow of 2.3 mgd with possible additional capacity needed for new development between Avon and Squaw Creek.

Interceptor replacement would be just slightly more extensive than that required under Alternative 3, since an additional 0.6 mgd would be in the lines in 1995 (from Bighorn). Total length of new or replaced interceptor lines would be 19.52 kilometers (12.13 miles). Alternative 4 is shown in Figure 23, on the following page.

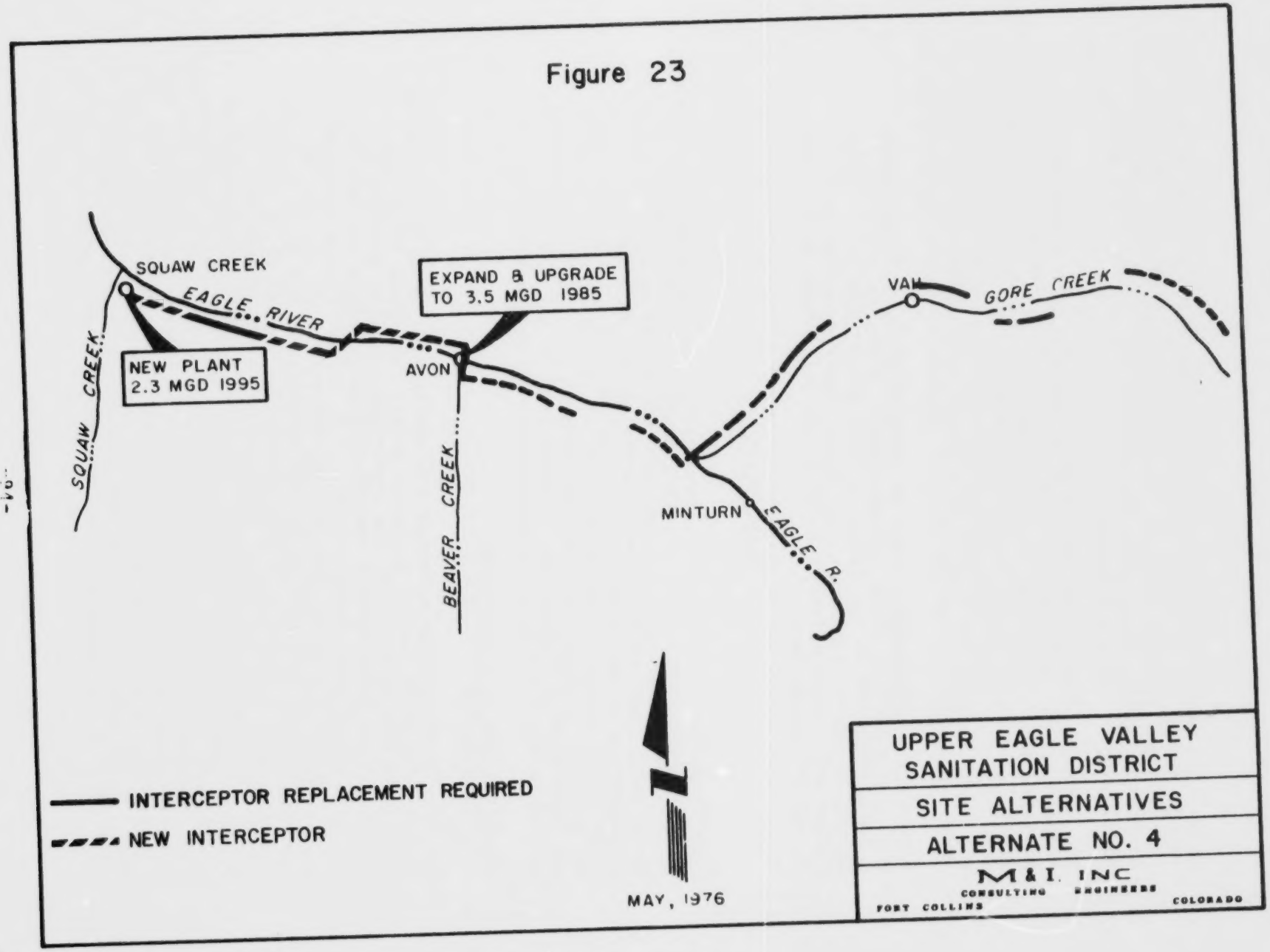
Alternative 5

The "No Project Alternative" assumes that no improvements whatsoever are made to the existing facilities of either district. It is also assumed that development and growth will occur as projected. This alternative illustrates the environmental consequences of not providing sewerage system improvements for anticipated growth. The alternative of no EPA funding, with the Sanitation Districts then deciding to fund their expansions and improvements themselves, is addressed in the Chapter, Institutional and Financial Considerations and Impacts.

THE SELECTION OF A PREFERRED ALTERNATIVE

The four alternatives selected for additional in-depth evaluation were discussed at length at meetings of: the Vail Water and Sanitation District Board, the Upper Eagle Valley Sanitation District, the Eagle County Board of Commissioners and the 201 Advisory Committee. Alternatives 1, 2, 4, and 5 were rejected, as were alternatives 3c and 3d. Of the remainder (3a and 3b) the specific subalternative to meet projected 1995 flows has not been determined in order to leave open the option as to whether to expand Avon or to build a new plant at a downstream site in 1985. The Squaw Creek plant site and service area downstream of the Avon plant is not presently within the Upper Eagle Sanitation District service boundary and is outside the study area for the EIS. Therefore, a decision of whether to expand the Avon plant in 1985 or construct a new plant near Squaw Creek in 1985 will not be made at this time. This decision will await future county development plans and will require additional environmental assessments outside the study area and the scope of this study.

Figure 23


SQUAW CREEK
EAGLE RIVER
SQUAW CREEK
NEW PLANT
2.3 MGD 1995
EXPAND & UPGRADE
TO 3.5 MGD 1985
AVON
BEAVER CREEK
MINTURN
EAGLE R.
VAIL
GORE CREEK
INTERCEPTOR REPLACEMENT REQUIRED
NEW INTERCEPTOR
MAY, 1976
UPPER EAGLE VALLEY
SANITATION DISTRICT
SITE ALTERNATIVES
ALTERNATE NO. 4
M&I INC
CONSULTING ENGINEERS
FORT COLLINS
COLORADO

TREATMENT PROCESSES

In this section, the recommended treatment processes are described and evaluated, and alternative methods are briefly discussed. The technical terms are defined in the Glossary section.

Preliminary and Primary Treatment

Proposed System -- Preliminary treatment at the UEVSD plant will consist of comminution with a manual screen bypass, preceded by aerated grit removal. At the existing Vail facility, mechanical screening without grit removal is proposed. Primary clarification will not be provided at any location; sewage will pass from preliminary treatment directly to the aeration basins.

Evaluation -- Comminutors are commonly used in smaller treatment plants, and while they are simple to operate, they are also susceptible to periodic breakdown. The principal advantage is that all solid material remains in the wastewater, thus no waste product must be handled. A mechanical screen is a simpler device, but requires greater attention and produces a waste product. Since grit removal is not proposed for the Vail plant, the screenings will be the only waste product produced.

Grit removal processes prevent excessive amounts of solids from entering the biological processes. A build-up of these non-degradable solids can displace mixed liquor and reduce process efficiency. Grit removal is essential when the sewage passes through long interceptor lines which are susceptible to infiltration and inflow. Aeration of the grit facilities at the downstream plant is highly recommended, since the incoming sewage may reach septic conditions in the long interceptor line, particularly in the summer. The aeration will freshen the wastewater and help minimize odors.

Primary settling customarily precedes aeration when the conventional activated sludge method (as proposed) is used. However, primary clarification can often be eliminated if the raw waste is largely domestic, contains no excessive grease, and grit removal is provided. Conventional activated sludge treatment is used successfully in Colorado in many locations (including Avon and Vail) without primary clarification. An advantage of the exclusion of primary settling is that the production of primary sludge is eliminated as is the need for additional sludge handling processes, equipment, disposal sites, and operator attention. However, the additional solids loading which will be imposed on the downstream plant(s) by the discharge of waste sludge to the interceptors at the upstream facilities may justify

economically the use of primary treatment, when weighed against the additional aeration (including aerated grit removal) which will otherwise be needed. Either method is environmentally sound; the choice is one of economics.

Other Alternatives -- If primary clarification is used, the sludge produced is more easily dewatered than secondary sludge, and in many plants the two sludges are mixed to provide more efficient dewatering of secondary sludge. Primary sludge lends itself well to anaerobic digestion, discussed later in this section.

Secondary (Biological) Treatment

Proposed Systems -- Secondary treatment will be accomplished by the conventional activated sludge process, followed by final clarification. New aeration basins and clarifiers will be used at the Vail plant. Because of the limited space available and highly variable loadings which must be handled by the Vail plant (under some of the site alternatives), aeration with pure oxygen is proposed as an alternative for this facility. Aeration will be provided with submerged turbines at the other treatment works.

Evaluation -- The activated sludge process is the most feasible secondary treatment method for this application, since a high degree of treatment can be obtained and a minimum amount of space is required. The conventional mode is the most commonly used technique for plants handling flows greater than 1 mgd. Biological processes are very susceptible to cold weather effects, which include retardation of oxidation and assimilation reactions and reduced oxygen transfer rates. Influent temperatures near 5 degrees Centigrade, such as have been recorded at Avon, require that certain design considerations be made, including reduced organic loading rates and the enclosure of the process in a heated building. Final clarifiers should be designed to allow for very conservative overflow rates. Both aeration tanks and clarifiers can be made rectangular to minimize required space and enclosure costs. Aeration with diffused air allows less exposure of the liquid to cold air, although this problem is reduced if the process is contained in a heated building. The activated sludge process is also susceptible to upset by shock loadings, although this will be somewhat compensated for with the use of flow equalization and tertiary filtration. A large amount of waste organic sludge is produced, at least 1000 lb. dry solids per million gallons treated. The present operation staffs at both the Vail and Avon plants are knowledgeable of this process, since it is currently being used at both locations.

Pure oxygen can be used in place of air in activated sludge processes. This reduces detention time (and thus decreases the required aeration tank size), allows for increased organic loading, and produces a highly concentrated sludge which is more easily dewatered, thus requiring less clarifier volume. A very small amount of aerosol vents from the system, since nearly all the gas (O_2) is used in the reaction. Environmentally this technique is attractive, but these advantages must be weighed against the costs associated with production and supply of oxygen.

Other Alternatives -- Various modifications of the activated sludge process offer possible alternatives to the conventional method. The complete mix process provides a uniform organic load throughout the reactor and is less susceptible to shock loads, but capital investments and power requirements are generally greater. With contact stabilization, the adsorption and oxidation phases are separated, and the tankage requirement is theoretically reduced. However, this technique is usually only recommended as a temporary back-up process when extra capacity is needed in the existing plant. High-rate treatment requires shorter detention times (less tankage), but produces greater sludge volumes and is highly susceptible to upsets. Extended aeration requires considerable additional tankage, although very little waste sludge is produced. The process is usually only recommended for very small plants. Other biological processes include aerated lagoons, which in cold climate areas require very large land areas, not physically or economically available. Trickling filters require more space than activated sludge systems, are generally less efficient, require primary clarification, and are more adversely affected by low temperatures.

Ammonia Reduction

Proposed System -- Should the proposed un-ionized ammonia standards be adopted by the state, it will be necessary to provide ammonia reduction processes at all plant locations. Since ammonia reduction to 2 mg/l will be sufficient to meet standards and the proposed allowable nitrate limitations are relatively unrestrictive, it has been determined that ammonia removal by in-plant biological oxidation (nitrification) to the nitrate form is the most feasible process to be used. Nitrification will be provided with tertiary, packed bed, submerged filter reactors. The filter media may consist of gravel, stones, coal or manufactured materials. Liquid flow is normally upward and oxygen is injected into the influent line or air is bubbled in from the reactor bottom. An aerobic environment is maintained to allow oxidation and assimilation by nitrifying bacteria.

Evaluation -- Biological nitrification is adversely affected by cold temperature. Ideal operating temperature is 31.5° C, yet during the winter, sewage temperatures less than 10°C are common, particularly at the Avon plant. Low temperatures severely retard the bio-reaction and lessen bacterial yield. To compensate, systems must be covered in heated buildings and designed for conservative hydraulic and organic loading rates. The proposed method, while a relatively new concept, is probably the nitrification technique least susceptible to cold weather effects, since it is compact and economically enclosed, and allows for bacterial growth on fixed media, which prevents bacteria loss during cold periods when cell yield is low. Post-clarification is not needed. The process may require as much as four months time for start-up. If the oxygen injection method is used, effluent must be recycled, due to the limited solubility of oxygen. Properly designed and operated, effluents containing 2 mg/l ammonia or less should be attainable under most climate conditions.

Other Alternatives -- Nitrification can also be accomplished with other tertiary processes, including downflow filters, bio-disc reactors and suspended growth (activated sludge) systems. All such processes must also be enclosed and kept as warm as possible. With the suspended growth process, clarification is required and must be designed with a very low overflow rate, since the bacteria are fragile and very difficult to settle. The aeration system may expose the liquid to cold air temperatures. Thus, this process, although the most commonly used technique, is least adaptive to cold climates. Either the downflow filter method or bio-disc process are feasible alternatives, since both can be economically covered and require minimal operating power. The processes are simple and do not require post-clarification, since the bio-mass is retained on the media. Nitrification can also be obtained to some degree within the activated sludge secondary treatment process by extending the reactor detention time. However, the level of nitrification achieved may fluctuate greatly, depending on organic loading. This rather unreliable method is not recommended where highly efficient and consistent ammonia removal is required.

Ammonia can also be removed from sewage with physical/chemical techniques, all of which can be immediately started up and shut down. Ion exchange concentrates all ammonia into a brine which must then be wasted (cannot be discharged). The process requires a high degree of pretreatment and is very expensive. Ammonia stripping, while effective in warm climates, will not function in air temperatures below 0°C, due to the extremely high solubility of ammonia gas; in addition, lime used to increase the sewage pH level results in a waste chemical sludge, but phosphates are also removed with this procedure. Breakpoint chlorination converts the ammonia to chloramines and eventually to nitrogen gas, which is easily stripped from solution; a large amount of chlorine is needed which greatly

increases the dissolved solids content of the effluent, and dechlorination is necessary for most receiving streams. (Dechlorination may also be required following chlorination for disinfection, although considerably less chlorine would likely be used.)

Sewage Filtration

Proposed System -- Gravity filtration will follow the nitrification process. The filters will be either dual or tri-media and their purpose will be to further reduce suspended bacteria remaining in the effluent from the activated sludge and nitrification processes.

Evaluation -- Filtration provides an excellent means for polishing biological secondary or tertiary effluent, since most BOD (organic material) is in the suspended form at this point and can be filtered. The use of a filter virtually assures that excessive BOD and suspended solids will not be discharged from the treatment plant. The space requirement is minimal which allows for economical enclosure, which is necessary to prevent freezing. Operation is simple, but periodic backwashing is required. A filter-aid chemical is usually needed, and the backwash water may increase the treatment plant hydraulic load by more than ten percent.

Other Alternatives -- When it is established that this type of tertiary polishing is needed, the only alternatives are other types of filters (upflow, pressure, etc.) or aerobic lagoons, which, in Colorado, are required by law for small treatment plants. High rate land application (infiltration/percolation) also provides good effluent polishing, but requires very large land areas for construction of percolation beds.

Flow Equalization

Proposed System -- An aerated flow equalization process is proposed for the Avon plant, and, under some alternatives, for the upstream facilities. The system will be placed ahead of the activated sludge aeration tanks so that this and all subsequent processes will have a continuous, non-fluctuating flow.

Evaluation -- Equalization is commonly used in industrial waste treatment, but usually is not necessary or economically feasible for domestic sewage plants. However, it can be extremely valuable in resort areas where plant hydraulic loadings may be highly variable over the course of a typical day. Processes which follow

flow equalization can be designed for lower peak flows, and process efficiency is increased. Aeration and mixing should be provided to prevent septicity and to keep all solids in suspension. The process should be enclosed to avoid exposure to cold air temperature.

Grit removal normally precedes equalization. Since grit removal is not proposed for the Vail facility, it may be more difficult to prevent settling in the equalization basin, if the flow equalization process is used. Provision for solids removal may be necessary.

The only alternative to flow equalization is to design the treatment processes to accept the extreme loading variations. Clarifiers should be designed for peak flows which could increase their size considerably. Biological processes designed for high loadings may not perform efficiently during low loading periods.

Sludge Processing and Disposal

As previously discussed, sludge handling will only be carried out at the downstream plant site (Avon). Sludge generated at the upstream facilities will be returned to the interceptor lines for conveyance to a downstream plant. With the proposed treatment processes described in this section, the only waste sludge which will be produced will be secondary activated sludge. This organic material consists mostly of carbonaeous bacteria, and is removed from the final clarifiers (following aeration) at a solids content of normally less than one percent.

Proposed Systems -- Sludge will be pumped from the final clarifiers directly to aerobic digesters. At Avon, the existing aeration tanks will be used for aerobic digestion, and aeration will be provided with submerged turbines. Following digestion, the sludge will be mechanically dewatered. Use of a centrifuge is proposed for this operation. The dewatered sludge will be trucked to a specified site and landfilled, unless more suitable disposal sites are found, such as use on golf courses, interstate highway median strips, public greenbelt areas, and private lands.

The aerobic digestion process was developed specifically to handle waste activated sludge produced from aerobic treatment plants without primary clarifiers. The operation is simple and well suited to the high water content and aerobic nature of the waste. The digested sludge is essentially odorless and has good drainability. It contains significant levels of nutrients and thus has agricultural value. The process is, however, adversely affected by cold temperatures, which retard the biological reactions and the rate of the reduction of volatiles. This constraint can be partially overcome by providing increased detention time and enclosing the process in a heated building. Aeration by surface agitation is discouraged because of the heat

losses which accompany this method. Even with such measures, it is likely that digestion efficiency will decrease during the winter. It is not usually economically feasible to provide heat to the process, since unlike anaerobic digestion, a fuel by-product such as methane gas is not produced with the aerobic process. Separation of liquid from solids by gravity in the digester is rarely effective without chemical addition, which could hinder the agricultural value of the sludge. However, if chemicals are not used, the supernatant return may contain a considerable amount of sludge.

Sludge dewatering should be provided whenever disposal is by landfilling. Mechanical dewatering allows this to be accomplished with a minimum space requirement. Chemical conditioning is usually necessary, and digestion, while not required for land-filling, also renders the sludge more dewaterable. The use of centrifuges for this purpose is far less common than the use of vacuum filters, but nonetheless feasible for smaller plants. The solid bowl scroll centrifuge is the most popular type used, and can be adjusted to provide for variable cake moisture and solids capture. Chemical conditioning reduces the amount of solids returned to the sewage plant in the centrate, but may render the sludge unsuitable for agricultural purposes. Operating the unit for maximum cake dryness could produce a dewatered sludge with a solids content as high as 20 percent.

Alternatives -- Anaerobic digestion, while a commonly used process, is not well adapted to activated sludges with high water content. Further, use of this technique would require completely new facilities since those now in use at the UEVSD plant are based on the aerobic principle. The process is best suited and commonly employed where primary clarification is used, which produces a thicker, less gelatinous sludge. Activated sludge must either be thickened or mixed with primary sludge prior to anaerobic digestion. Since activated sludge will not readily thicken by gravity alone, dissolved air flotation would probably be necessary. Anaerobic digestion produces a sludge reduced in volume, volatiles, and odors. Methane gas is produced as a byproduct, and can be captured and used as a fuel to heat the digester, which is necessary since operating temperatures normally should be in the 32.2° to 35° C range. The process is complex and susceptible to upset, but less affected by cold temperatures if properly heated. Anaerobic digestion would be highly recommended if primary treatment were to be used at the downstream plant, since the constant heat supply (from utilizing the methane gas) would provide for consistent digestion efficiency, regardless of climate conditions.

Vacuum filtration is the most common mechanical sludge dewatering method used in the United States. Properly operated, and with the use of chemical conditioning, the process can be optimized to produce a dry cake and minimize the amount of

solids returned to the plant in the filtrate. Such high efficiency may not be as easily attainable with a centrifuge. Vacuum filters generally do not perform well with aerobic sludges unless they are effectively digested or thickened.

Sludge dewatering on sand beds is the simplest technique. However, large amounts of land are necessary, and pretreatment with digestion is recommended to reduce odors and sludge volume. Because of the adverse winter climates, it would be necessary to either cover the drying beds or provide extensive sludge holding facilities. Sludge dewatered on sandbeds attains a very dry state, which significantly reduces sludge volume and subsequently the number of truck hauls to the landfill site. In some locations, sludge beds have been poured during cold weather and allowed to freeze, which resulted in rapid dewatering when the sludge thawed. Additional bed capacity would be needed to implement this concept, since sludge would not be periodically removed during the winter season.

Most other sludge handling processes are either economically or environmentally unfeasible. These include incineration, which has high power requirements and results in discharge of particulate matter to the air. Reduction of such air pollution requires considerable additional power and expense. Sludge heat drying is also expensive since an outside fuel source is needed, although the dried sludge can sometimes be marketed. Heat conditioning is very complex, produces a dry inert sludge (no agricultural value) and greatly increases the organic load on the treatment plant.

Disinfection

By July 1, 1977, in accordance with PL 92-500, certain secondary treatment standards must be met at sewage treatment facilities. By this date, the Vail, Avon and Red Cliff treatment works must reduce fecal coliform count in discharged effluent to less than 12,000/6,000 mg/l (30 day average), and this limit will also be imposed upon any new treatment plants in the study area. At the present time, disinfection requirements are not so restrictive.

Proposed Systems -- Chlorination is presently used at the existing facilities, and it is proposed to continue this practice at these and all new sites, if possible. However, it may be found that the required disinfection level cannot be attained with chlorination without discharging excessive chlorine residuals to the receiving stream. This may be particularly true at Vail, where the low winter flows of Gore Creek limit its ability to accept chlorine residuals without the recommended in-stream chlorine levels being exceeded.

Where chlorination cannot be used for this reason, alternatives must be proposed. Those recommended are disinfection with ozone instead of chlorine, or chlorination to the extent necessary, followed by dechlorination with sulfur dioxide (SO_2). In any event, stream standards must be met.

Evaluation -- Chlorination is the most common disinfection method used in wastewater treatment. Historically, it has provided good disinfection, attaining required kill levels within 20 to 30 minutes of contact time with reasonably low residual discharges. However, it will be difficult to attain the extremely high kill level required in 1977 and, at the same time, discharge the very low chlorine residuals necessary to maintain stream water quality standards. The Colorado River Water Quality Management Plan assumes that other disinfection methods will be needed in the mountain areas, since water quality requirements in cold water bodies are generally more stringent. Cold receiving waters further aggravate chlorination, in that fecal coliform bacteria tend to survive longer and chlorine residuals dissipate at a significantly slower rate. It is expected that the use of chlorination alone in the Vail area will not be sufficient to meet both kill and chlorine residual requirements. In treatment works discharging to the Eagle River, chlorination may be found to be adequate, but will require extended contact periods and efficiently designed contact chambers.

Ozone (O_3) appears to be the most feasible alternative for disinfection. Ozone is more expensive than chlorine and operations and maintenance are more complex. However, ozone does not maintain a long-lasting residual. It is generated on-site, thus eliminating the need to transport and store hazardous chemicals. However, a considerable amount of electrical power is needed, and a standby source must be available for power failures. Ozone also poses a more difficult industrial health hazard than chlorine, although both require care in handling and operation. A much shorter contact period is necessary than with chlorine to attain the required kill, and ozone also provides oxidation potential for further reduction of BOD and odors.

The purpose of dechlorination is to allow chlorine to be applied in necessary amounts to obtain the required kill, without fear of discharging excessive residuals to the receiving stream. Dechlorination with sulfur dioxide gas (SO2) removes both free and combined chlorine residuals from wastewater. SO_2 is a reducing agent, and when added to chlorine and water, produces hydrochloric and sulfuric acids. Very little contact time is necessary; the reaction is instantaneous and application of SO_2 can be made at the end of the chlorine contact chamber and mixed mechanically. The amount is used directly proportional to the amount of residual to be removed. The gas must be stored and

applied under pressure, much the same as chlorine, and the storage temperature is very critical. Accurate and responsive metering is necessary to insure that sufficient dosages are always applied. All the chlorine residual will not necessarily be removed, but this technique appears to be among the more reliable dechlorination methods.

Other Alternatives -- Other disinfection methods include the use of iodine, bromine-chloride and other halogens, and lime to raise the pH value. Halogens, primarily used as emergency disinfectants in water supply systems, are highly soluble (long lasting residuals) and very expensive. Raising the pH above 11.5 achieves good disinfection, but the use of lime (although temperature independent) produces large amounts of chemical sludge and imposes high capital and operating costs.

Other dechlorination techniques include the use of aeration, activated carbon adsorption, and other reducing agents such as sodium bisulfite and sodium thiosulfate powder, which is commonly used to dechlorinate samples for bacteriological analysis. Aeration will remove the more volatile forms of chlorine, but is insufficient for combined residuals found in sewage such as mono and di-chloramines. Activated carbon is highly effective for chlorine and other organic residuals, but the use of powdered carbon is not sufficient, and granular carbon columns impose high capital and operation costs.

Sewage Effluent Irrigation and Agricultural Sludge Application During the Summer

Proposed Systems -- Although not specifically included with the proposed treatment schemes, both of these concepts could eventually be used during the summer growing season. Treated effluent can be used to irrigate golf courses and parks. Dewatered digested sludge can be used on highway medians and area croplands.

Evaluation -- It must be emphasized that the purpose of these endeavors would not necessarily be additional sewage or sludge treatment. No in-plant processes would be bypassed while land application was being carried out. The primary purpose would be to make use of a resource that otherwise would be wasted, and to reduce the quantity of potable water demand for irrigation, since large amounts of potable water are used for this purpose in the summer. To be sure, nitrogen (in ammonia or other forms) will be taken up by plant life, but the in-plant nitrification process must not be shut down even if all effluent were used in irrigation, since the process could take four months to restart when the growing season was over.

Irrigation with effluent is common in Colorado. The degree of treatment which will be provided at the plants will produce a quality effluent high in nutrient content and well suited for irrigation. Since the water will not be potable, separate pipelines will be required, which will economically prohibit irrigation of individual lawns. Effluent irrigation should not affect water rights, since an equally less amount of raw water will need to be delivered to meet the irrigation demand.

Properly digested sludge, as previously pointed out, is relatively harmless and has a high agricultural value. Sludge produced at the Avon plant has, in the past, been used for this purpose, and it is anticipated that in the future there will continue to be a demand for a significant portion of the produced sludge during the growing season. Usage of sludge in this manner will also reduce landfill capacity requirements. Undigested sludge, or sludge improperly applied, can cause ground water contamination, as discussed under non-point pollution in Chapter II. Before any program is seriously undertaken, a study should be made of the proposed sites as to soil type and application rates.

III ENVIRONMENTAL IMPACTS

Environmental impacts are the conditions caused, or brought about, as a result of the proposed action. They may be adverse or beneficial to the project area or the surrounding area. Impacts are categorized as primary, as the direct result of construction activity or plant operation, and secondary, as an indirect result of the proposed action, the impact of population growth associated with wastewater facilities. Future population, land use and air quality projections were presented in the existing social environment since the level of future human activity could be the same with or without the proposed action.

The impacts chapter is presented under the following headings: Primary Impacts of the Proposed Action and Impacts of Growth Associated with Wastewater Facilities.

PRIMARY IMPACTS OF THE PROPOSED ACTION

The primary level impacts of the proposed sewerage system expansion are categorized into the following: geology and soils, biological, noise, water quality and streamflow alteration. Some of these impacts will occur during both the construction and operation phases.

In this chapter, the discussion of impacts of the various alternatives will be combined whenever a particular effect applies equally and discussed separately where differences in magnitude or in kind apply. The major primary impacts of the alternatives have been summarized and are presented in Table 21,on the following page.

Alternative 5 allows for the beneficial impacts of the proposed action to be considered, since without it, detrimental impacts would occur to the aquatic biota, water quality and human health. (The no funding possibility is discussed in the next chapter on financial considerations.)

Geology and Soils

The existing treatment plants within the study area are built on gravel terraces which were deposited by the Gore Creek and the Eagle River. These terraces are geologically stable, and impacts from additional construction activities in these areas will be minor. The construction of a new plant at Dowds Junction on the

TABLE 21

IMPACTS SUMMARY

Nature of the Impact

Number of Alternative	Geology and Soils	Biological	Water Quality	Streamflow Alteration	Engineering
Alternative 1					
New Plant at Dowds Junction 2.6 mgd	Geologically stable area, minimal impact. Will aid in clearing debris.	Loss of 5 acres of predisturbed area - weedy species. Sedimentation of streams, loss of aquatic biota (same as for all alternatives).	Moderate sedimentation and habitat destruction at 2 sites during construction and along interceptors.	Very detrimental to aquatic life due to depletion of Gore Creek.	Probable septicity in the lines below Dowds plant.
Expand Avon in 1977 to 2.5 mgd and in 1985 to 4.7 mgd*.	No impacts, geologically stable area (gravel terrace, out of flood plain).	Loss of 6 acres of predisturbed area.			Sewage pumping of Arrowhead flows.
Replace Interceptors	Temporary disturbance of drainages.	14 acres disturbed along interceptors.			
Alternative 2					
Abandon Vail	None	Loss of aquatic biota during low flow.	Same as #1 (a little more interceptor line replacement).	Severely detrimental to aquatic life due to vast depletion in Gore Creek flow.	
New Plant at Dowds Junction 4.1 mgd	Same as #1	Loss of 6 acres of pre-disturbed area.			Pumping of Arrowhead flows.
Expand Avon as in Alternative 1	Same as #1	Same as #1			
Replace Interceptors	Temporary disturbance of minor drainages.	15.4 acres disturbed along interceptors.			
Alternative 3					
(with or without flow equalization)					
Expand Vail 3.0 mgd	No impact, stable area.	Loss of 1 acre.	Less disturbance to streams and loss of aquatic biota and terrestrial habitat with 3a,c. Severe disturbances to both with 3b,d.	Not detrimental to aquatic life/little change in stream flow for all subalternatives.	Probable septicity in lines below Vail plant.
Expand Avon 3.5 mgd	Minimal impact stable areas.	Loss of 4 acres of pre-disturbed area			Pumping of Arrowhead flows (3a-c)
Replace Interceptors					
Subalternatives a-c*					
Expand Avon to 5.8 mgd in 1985	Minimal impacts.	Loss at 2 acres of pre-disturbed area.			
Replace Interceptors	Temporary drainage disturbances.	Disturbance of 10 acres along interceptors.			
Subalternatives b-d*					
Build new plant downstream in 1985, 2.3 mgd	Potential loss of gravel resources.	Loss of 10 acres of natural vegetation.	Severe losses of riparian habitat, probable with a new plant.		
New Interceptors	Location undetermined, potential subsidence.	Disturbance of 10 acres of natural vegetation.			
Alternative 4					
(no Vail participation)					
Expand Avon to 3.5 mgd	Same as Above	Same as #3	Same as #3	Moderately detrimental to aquatic life.	Possible sewage pumping if Avon plant were expanded.
In 1985, new plant or* expand Avon plant	Same as Above	Same as #3	Same as #3		
New or Replaced Interceptor	Same as 3b,d	Same as 3b,d			
Alternative 5					
No action	No impact	Severe detriment to aquatic life due to water quality deterioration. Disease threat to wildlife. Destruction of riparian vegetation.	BOD and SS loadings very high. Ammonia and chlorine pollutant levels reach toxic levels for aquatic biota.	No impact	No impact

* Not a part of the proposed action.
Source: CDM

terrace between I-70 and Gore Creek would cause negligible impacts since considerable alteration has occurred from the fill activities of the railroad and highway, and from the construction of several abandoned cabins which exist on this site (Alternatives 1 and 2).

Future construction at a downstream site is not an immediate part of the proposed project, but is rather a proposed expansion in capacity to be considered for construction in 1985. The site for a new downstream facility would potentially conflict with the development of existing valuable gravel resources and should be selected with these resources in mind.

Interceptor construction (line replacement) will affect the present route, thus having little impact on the geology or soils of the area. Future construction of interceptors to a downstream site cannot be evaluated until an alignment has been selected. This would occur in 1985 if the option to build facilities downstream were selected.

Biological

The overall impact to vegetative communities from any of the proposed alternatives is expected to be minor. If revegetation programs and reclamation procedures are followed, local vegetative communities could actually become more diverse and could support more wildlife.

The riparian and lowland meadow communities are the primary ones to be affected by the proposed construction activity. Neither community represents a unique habitat. The areas of disturbance for these communities, summarized by alternative in Table 24 , represent only a small portion of the total area of each community.

Expansion and upgrading of existing plants for all alternatives will take place in previously and/or recently disturbed areas. Plant life at these sites is composed primarily of weedy species. Even the new plant proposed in Alternatives 1 and 2 at Dowds Junction is on land already stripped of natural vegetative cover.

The quantification of total acres of vegetative disturbance was calculated from preliminary construction drawings. An average overall width of disturbance of 15 feet was assumed. These calculations are utilized partially to indicate the relative impacts, while total acres disturbed may be larger depending upon equipment and the amount of care taken to minimize disturbance. Trees are to be avoided according to the design engineer, due to their relative scarcity and the length of time for revegetation. In addition, some of the areas are along predisturbed routes, in streambeds, in roadbeds and in areas which have little or no vegetation.

All alternatives as shown in Table 26 represent nearly identical vegetative disturbances, with the exception of 3b, d and 4. In these alternatives, the construction of a new plant in 1985 would necessitate the removal of approximately 10 acres of natural vegetation at the plant site and another 10 acres along a new interceptor route. (These latter effects will not be decided until an option is selected just prior to 1985.) The no action alternative would cause no impacts to terrestrial vegetation.

Due to the close association between wildlife and vegetation, the effects to wildlife are closely linked to the impacts to vegetation. The wildlife inhabitants of the riparian and lowland meadow communities will thus be most affected by construction activity.

The construction will affect wildlife directly by removing wildlife habitat and by causing wildlife to flee the areas of increased noise and activity. Some burrowing animals, unable to flee, may be destroyed by construction activity. All alternatives will create a negative impact to prey species hunted by raptors, but the immediate effect will be minor since a small portion of the total habitat area will be destroyed.

No big game animals, raptors, or threatened or endangered species permanently reside in the area of direct impact of any of the alternatives.

All of the alternatives (1-4) will have a minor impact on terrestrial wildlife. Alternatives 3b, d and 4 present the most detrimental impacts due to the removal of up to 20 acres of riparian and lowland meadow habitat that has been previously undisturbed (10 acres permanently removed and 10 acres temporarily removed). Alternative 5 represents the most serious threat of all the alternatives to the wildlife in the area, due to the potential outbreak of disease caused by a severe degradation in water quality.

The aquatic biota (including fish) will be the most affected of all the biological communities. The impacts will occur during two distinct phases, construction and operation.

Alternatives 1-4 present significant short-term effects on aquatic biota during construction. Environmental problems relating to increased stream suspended sediment loading will pose the greatest threat to aquatic biota. Adverse effects of high levels of suspended sediment loads on aquatic biota include:

- Clogging and irritation of breathing apparatus of aquatic organisms

- An increase in the scouring of benthic organisms from the stream substrate

- Impaired vision and resultant decreased feeding efficiency of a number of local species of fish

- A decreased hatch of fish spawn

- A potential increase in re-suspension or dissolution of sediment-bound pollutants

- A potential decrease in aquatic primary productivity due to decreased amounts of available light reaching aquatic plant life

- A potential change in the "normal" temperature of the stream due to a change in the thermal characteristics

The increase in turbidity will be caused by heavy equipment activity in and adjacent to the Gore Creek and the Eagle River during interceptor construction from surface runoff and channelization.

The larger, more mobile aquatic species such as fish and invertebrates will be able to avoid the turbid waters. These species may move upstream above the construction activity or downstream where the sediment load has settled or been diluted. This, in the case where public fishing access is available, and construction is taking place, will cause temporary loss of a recreation resource, a temporary but unavoidable impact.

In addition to impacts resulting from increased turbidity, periphyton, benthos and fish communities may be impacted during construction by a direct loss of habitat due to the operation of construction equipment within Gore Creek or the Eagle River. Mobile species, which are able to move to new habitat, will not be significantly affected by habitat destruction since only a very small portion of available aquatic habitat will be disturbed. Immobile inhabitants, such as periphyton or certain benthic organisms that are unable to avoid highly turbid waters or physically disturbed areas, will be destroyed. However, the ability of the benthic and periphytic communities to rapidly repopulate a disturbed portion of stream, causes the overall impacts of a temporary loss of a small portion of these communities to be minute.

Other adverse impacts on the aquatic community could result from the contamination of the water by grease or oil from construction equipment. Such material can be directly toxic to aquatic organisms by poisoning or it may result in suffocation by interfering with breathing apparatus.

Alternatives 1 and 2 involve the construction of over eight miles of interceptor line and over ten stream crossings between Bighorn and Dowds Junction, while Alternatives 3 and 4 involve the construction of approximately five miles of interceptor line and seven actual stream crossings in this area. All of the alternatives present essentially the same potential for increased suspended sediment loading of Gore Creek and the Eagle River

during interceptor line construction, especially when considering that the construction is staged. The major difference between the alternatives will result from the construction of new facilities (Alternatives 1, 2, 3b, 3d and 4) and/or extended interceptor lines below Avon (Alternatives 3b, 3d and 4).

Construction area disturbances required by Alternatives 3b, 3d and 4 are among the greatest of any of the alternatives proposed because, in addition to new site construction, approximately ten miles of new interceptor construction would be required. Any of these alternatives would be expected to produce greatly increased sediment loading to the Eagle River.

Alternative 5, no action, would cause no construction related impacts. However, the adverse impacts on the stream biota caused by selection of this alternative are judged to be the most detrimental of any of the alternatives.

As a result of population increases within the study area, particularly the Eagle River Valley, a number of substances which were not discharged prior to the 1960's into the area's surface waters currently are, and will continue to be, discharged. As populations increase, the number and volume of these substances will increase. In addition, a number of naturally occurring substances are now being discharged in volumes and concentrations which are much higher than natural levels. Degradation of water quality within Gore Creek and the Eagle River are unavoidable adverse impacts which accompany population increases in the study area; however, the adverse effects of these pollutants could be the most detrimental if no new facilities were built. A discussion of the projected pollutant loadings of Gore Creek and the Eagle River, with each of the proposed alternatives, was presented in Chapter III. The following is a discussion of the effects which these projected loadings will have on the biota within the area. A summary of the effects of these constituents, both construction and operation related, is presented in Table 22, on the following page.

Water Quality and Hydrology

The purpose of this section is to evaluate the alternatives (including "no action") with regard to their impact on the receiving streams. It has been stated by the consulting engineer, and is to be assumed, that the discharged effluent from all treatment facilities will meet the following criteria:

- BOD and Suspended Solids 10 mg/l each
- Ammonia 2 mg/l

An evaluation of the ability of the proposed processes to meet

Table 22

SUMMARY OF OVERALL POTENTIAL ADVERSE EFFECTS OF THE PROPOSED ALTERNATIVES ON AQUATIC BIOTA, UPPER EAGLE RIVER VALLEY

Constituent	Alternate 1	2	3a	3b	3c	3d	4	5
Construction Related Effects								
Turbidity	c	c	b	d	b	d	d	a
Habitat Destruction	c	c	b	d	b	d	d	a
Oil or Grease Contamination	c	c	b	d	b	d	d	a
Operation Related Effects								
BOD, D.O., SS	b	b	b	b	b	b	b	e
Ammonia	b	b	b	b	b	b	b	e
Loss of Stream Flow	d	e	a	a	a	a	c	a
Chlorine Residual[1]	b	b	b	b	b	b	b	b

NOTES:

a = Not detrimental to aquatic life

b = Little detriment to aquatic life

c = Moderately detrimental to aquatic life

d = Detrimental to aquatic life

e = Severely detrimental to aquatic life

BOD = Biochemical Oxygen Demand; DO = Dissolved Oxygen; SS = Suspended Sediments

[1] = Assumes proper and adequate dechlorination.

SOURCE: CDM

these criteria with other engineering considerations, has been made in Chapter III, including the proposed sludge conveyance plan. The following analysis addresses the effects of projected stream loadings on receiving streams and also on the aquatic biota within the area. A summary of the overall impacts to the biota during both construction and operation is given in Table 23 on the following page.

BOD/Suspended Solids (SS) Loading -- With all treatment works designed adequately for cold weather and flow variation, and all units performing properly, daily BOD and SS discharges will be below permit limitations, and in-stream BOD and SS concentrations will not exceed the proposed limits being considered for the new Colorado Water Quality Standards (1976). Additional solids and organic loading regulations will be imposed on the downstream plants due to the discharge of activated sludge from upstream facilities to the interceptor system. This must be accounted for in plant design. The data displayed in Table 23 represents the most adverse loading conditions, e.g., minimum annual 7-day/10-year low stream flow and no in-stream oxidation of discharged BOD from upstream points, allowing an accumulation of BOD and SS.

With no improvements provided, by 1995 large amounts of untreated sewage will be discharged at both plants, as well as other points, due to the limited flow capacity of the interceptor system. Under the most adverse conditions, BOD and SS levels in the Eagle River would reach 60 mg/l, as shown in Table 23. This will cause stream oxygen depletion, turbidity, solids accumulation, and build-up of grease and scum on the water surface. Since mountain streams reaerate rapidly, septic conditions would be unlikely, and these streams would probably maintain adequate oxygen levels for the protection of most aquatic life.

Ammonia Loading -- Most secondary treatment plants remove only a minimal amount of ammonia contained in sewage through biological uptake. Nitrification has been observed during the summer in both the Avon and Vail plant, primarily due to the dilute loading caused by infiltration. Therefore, ammonia removal facilities are proposed for all existing or new treatment plants. It has been stated by the consulting engineer that the processes used will be able to reduce total ammonia content to 2 mg/l, which is assumed to produce un-ionized in stream ammonia levels of .02 mg/l or less. These levels should ensure the protection of aquatic biota, as discussed earlier.

Table 24, following Table 23, depicts the total ammonia loadings which will be discharged to the receiving streams in 1995 with all facilities operating at full capacity. Such loadings will, in all probability, occur only in the winter during the peak ski season. These loadings assume total ammonia background levels of 0.10 mg/l in both streams. The

TABLE 23

BOD/Suspended Solids Loading in 1995

For Minimum 7-day/10-year low flow[1]: Eagle River - 36.7 cfs
Gore Creek - 12.1 cfs

Required In-stream limits[2]: BOD - 5 mg/l
SS - 25 mg/l

Alternate No.	Discharge Point	Daily Plant Flow (mgd)	Discharged BOD (lb./day)	Discharged SS (lb./day)	Resulting Avg. Stream BOD (mg/l)	Resulting Avg. Stream SS (mg/l)
1	Vail	1.5	125	125	1.9[3]	1.9[3]
	Dowds	2.6	217	217	1.7[3]	1.7[3]
	Avon	4.7	392	392	3.7[3]	3.7[3]
2	Dowds	4.1	342	342	1.7[3]	1.7[3]
	Avon	4.7	392	392	3.7[3]	3.7[3]
3	Vail[4]	3.0	250	250	3.8[3]	3.8[3]
	Avon[5]	5.8	483	483	3.7[3]	3.7[3]
	Avon[5]	3.5	292	292	2.7[3]	2.7[3]
	Squaw Ck.[5]	2.3	192	192	3.7[3]	3.7[3]
4	Avon	3.5	292	292	1.5[3]	1.5[3]
	Squaw Ck.	2.3	192	192	2.5[3]	2.5[3]
5	Vail[6]	3[7]	3100[6]	3100[6]	48[3]	48[3]
	Avon[6]	5.8[7]	6900[6]	6900[6]	60[3]	60[3]

NOTES:

1 NHPQ, 1975
2 From proposed new Colorado Water Quality Standards (Colorado Department of Health, 1976)
3 Includes accumulation from upstream discharge (excludes N.J. Zinc and Redcliff)
4 Expand Avon, no new Squaw Creek plant (alt. 3a, 3c)
5 Build new Squaw Creek plant (alt. 3b, 3d)
6 Based on discharge of raw sewage in excess of current plant capacity, BOD and SS of 250 mg/l
7 Total flow - may be in excess of plant or interceptor capacity

SOURCE: CDM Inc., Colo. Dept. of Health (1975), NHPQ (1975)

TABLE 24

Maximum Ammonia Loading in 1995

During Peak Ski Season[1]

Alternate Number	Discharge Point	Plant Flow (mgd)	Total NH_{3-N} Discharged (lb/day) (with ammonia removal)	Total NH_{3-N} Discharged (lb/day) (without ammonia removal)[5]	Wasteload Allocation (lb/day)[2,12]	Average Resulting Stream Total NH_{3-N} Conc. (mg/l)[3, 11] (with ammonia removal)	Average Resulting Stream Total NH_{3-N} Conc. (mg/l)[3, 11] (without ammonia removal)[5]	Total Stream Ammonia Allowed to Maintain Un-ionized Conc. Less Than 0.02 mg/l (mg/l)[4] (winter)[6]
1	Vail	1.5	25	106	62	0.33	1.40	0.93
	Dowds	2.6	43	229				
	Avon	4.7	121[7]	645[7]	245	0.58	3.09	1.27
2	Dowds	4.1	68					
	Avon	4.7	146[7]	778[7]	245	0.70	3.73	1.27
3	Vail	3.0	50	212	62	0.67	2.84	0.93
	Avon[8]	5.8	97	517	245	0.46	2.45	1.27
	Avon[9]	3.5	58	309				
	Squaw Ck.[9]	2.3	97[7]	517[7]	245	0.46	2.45	1.27
4	Avon	3.5	58	309				
	Squaw Ck.	2.3	97[7]	517[7]	245	0.46	2.45	1.27
5	Vail	3.0	-	375[10]	62	-	5.0	0.93
	Avon	5.8	-	725[10]	245	-	3.5	1.27

NOTES:

1 For 7-day/10-year winter low flows for which minimum ammonia allocation exists: Eagle R. - 38.8 cfs; Gore Ck. - 13.9 cfs (NHPQ, 1975)
2 From NHPQ, 1975 and current UEVSD discharge permit (based on 0.02 mg/l max. un-ionized)
3 Values do not include any background ammonia present
4 At historical pH and temperature (NHPQ, 1975) (Willingham, 1976)
5 Based on ammonia measurements made at the existing plants (M & I Inc., 1976)
6 Based on winter 7-day/10 year low flows and historic pH and temperature (NHPQ, 1975) (Willingham, 1976)
7 Includes accumulation from upstream discharge at Avon or Dowds
8 Expand Avon, no new Squaw Creek plant (alt. 3a, 3c)
9 Build new Squaw Creek plant (alt. 3b, 3d)
10 Based on discharge of 15 mg/l total ammonia from total flow - new and treated
11 Values do not include any background ammonia present
12 Value for Vail assume a Dec.-July allocation of 62 lb/day (not in present permit), based on NHPQ (1975)

SOURCE: CDM Inc., M & I Inc., NHPQ (1975), Willingham (1976)

total ammonia levels which can exist during the winter in both streams before 0.02 mg/l is reached are given for comparison with the maximum in-stream levels, which will result from full capacity plant operation. Also included in the table are ammonia loadings which would occur if ammonia removal processes were not included with the alternatives. These values are based on past ammonia effluent measurements made at the existing plants, and thus are approximate.

Toxicity of ammonia increases with higher temperatures, thus the critical loading period in many situations is in the summer. Established wasteload allocations are often considerably less in summer, as is the case for the Eagle River and Gore Creek. However, sewage loadings (not including infiltration) are also less during the summer in the resort areas. From examining previous records of water use, sewage maximum and minimum flows, and community retail sales, it can be estimated that the peak summer population in Vail occurs in August and that total occupancy (and thus sewage flow excluding infiltration) is approximately 60 percent of the normal winter season level. Assuming this trend will continue, Table 25, on the following page, displays the ammonia discharges resulting from each alternative with all facilities operating at 60 percent capacity, with or without ammonia removal facilities included. These values are compared to the established wasteload allocations and acceptable in-stream concentrations (based on the same EPA criteria) for the month of August.

From examining the tables, it can be shown that for all alternatives except no action, the proposed ammonia wasteload allocations and maximum stream concentrations will not be exceeded during the winter ski season or during the peak summer period, given that all facilities provide for reduction of ammonia to 2 mg/l or less. Less efficient ammonia removal could be allowed at certain times without these recommended levels being surpassed.

The data does not account for the following:

- Ammonia discharge or seepage from the New Jersey Zinc Corp. tailings ponds can by itself cause un-ionized ammonia concentrations above 0.02 mg/l to occur in the Eagle River. Sufficient allowance for this ammonia was not made when the present ammonia limitations were established in the Colorado River Basin Plan and subsequent studies, and this ammonia, in combination with the ammonia which will be discharged at Avon in 1995, may create excessive levels in the river.

- Colorado has not yet established an ammonia standard, although the 0.02 mg/l un-ionized limit is included in the proposed new Colorado Water Quality Standards. If in-situ toxicity testing determines that this level is either too high or too low, changes in the restrictions could be invoked.

TABLE 25

Ammonia Loading

During August at 60 Percent Operation[1]

Alternate No.	Discharge Point	Daily Plant Flow[2]	Total NH_{3-N} Discharged[3] (lb/day) (with ammonia removal)	Total NH_{3-N} Discharged[3] (lb/day) (without ammonia removal)	Wasteload[4] Allocation (lb/day)	Resulting Stream[5] Total NH_{3-N} Conc. (mg/l) (with ammonia removal)	Resulting Stream[5] Total NH_{3-N} Conc. (mg/l) (without ammonia removal)	Total Stream Ammonia Allowed to Maintain Un-ionized Conc. Less[6] Than 0.02 mg/l, (mg/l) (August)
1	Vail	.9	15	64	36	0.15	0.64	0.46
	Dowds	1.6	26	139				
	Avon	2.8	73[6]	389[6]	109	0.24	1.28	0.46
2	Dowds	2.5	41	218				
	Avon	2.8	88[6]	469[6]	109	0.29	1.55	0.46
3	Vail	1.8	30	127	36	0.30	1.27	0.46
	Avon[7]	3.5	58	309	109	0.19	1.01	0.46
	Avon[8]	2.1	35	187				
	Squaw Ck.[8]	1.4	58[9]	309[9]	109	0.19	1.01	0.46
4	Avon	2.1	35	187				
	Squaw Ck.	1.4	58[9]	309[9]	109	0.19	1.01	0.46
5	Vail	1.8	-	225	36	-	2.25[10]	0.46
	Avon	3.5	-	435	109	-	1.45[10]	0.46

NOTES:

1 For 7-day/10-yr low flows (Eagle R. - 56.3 cfs, Gore Ck. - 18.7 cfs) (NHPQ, 1975)
2 Not including infiltration, flows are 60% of max. design flows
3 Derived from ammonia measurements made at existing plants (M & I, Inc., 1976)
4 From NHPQ, 1975 (based on 0.02 mg/l max. un-ionized) allocations for August only
5 Does not include background ammonia
6 Derived from historical pH and temperature (NHPQ, 1975) (Willingham, 1976)
7 Expand Avon, no new treatment plant (alt. 3a, 3c)
8 Build new Squaw Creek plant (alt. 3b, 3d)
9 Includes accumulation from upstream discharge
10 Derived from discharge of 15 mg/l total ammonia from total flow - raw and treated

SOURCE: CDM Inc., M & I, Inc., NHPQ (1975), Willingham (1976)

With no treatment improvements (Alternative 5), ammonia in concentrations of at least 15 mg/l will be discharged with both treated and raw sewage. During the winter, un-ionized ammonia levels could exceed .08 mg/l (including New Jersey Zinc), and will be greater than .12 mg/l in Gore Creek, a level which would most certainly have detrimental, and probably toxic, effects on aquatic life.

Chlorine Residual Discharge -- Chlorination of sewage for disinfection results in the reaction of chlorine with certain wastewater constituents to form combined chlorine residuals. The most common of these are Cyanogen Chloride (CNCl) and the chloramines (NH_2Cl, $NHCl_2$). All are toxic to fish. Although some residuals, under certain circumstances (pH, temperature, etc.), are present in greater amounts or are more toxic than others, all residuals can be considered as one total amount at a given concentration. The proposed Colorado Water Quality Standards recommend a maximum concentration of total chlorine residual of .003 mg/l in waters designated to support cold water aquatic life.

Table 26, on the following page, denotes the maximum chlorine residual discharges that would be allowed from each plant for each alternative in 1985 and in 1995, at extreme low flow conditions to insure that the proposed .003 mg/l limit is not exceeded. These values cannot account for the following considerations:

- Combined residuals could remain in solution for extended periods. Since the residual discharged by an upstream plant could partially be present as the stream flow was passing a downstream plant, the downstream facility could be required to further reduce the level of its residual discharge.

- The data assumes that complete mixing will occur in the stream, allowing for an even dispersion of the residual, which is not likely to occur; concentrations will vary throughout the stream. Because fish are capable of avoiding areas of excessive residual content, they may not be adversely affected, even with average residual levels above .003 mg/l.

The Colorado River Water Quality Management Plan states that, for the anticipated growth, the Vail and Upper Eagle Districts will both require either an alternative method of disinfection for wastewater or a dechlorination step in the treatment scheme prior to effluent discharge. The 303(e) management plan suggests disinfection by ozonation as an alternative method, which could be the final selection for a disinfection process in order to meet permit stipulations.

If no action were taken (Alternative 5), the chlorination facilities

TABLE 26

1985 and 1995 Chlorine Residual Discharge Limitations for Extreme Low Flow Conditions to Maintain .003 mg/l Total Residual in Stream

Alternate No.	Discharge Point	Min. Stream flow (cfs)[1]	1985 Plant Max. Ave. Flow (mgd)	1985 Max. Allowed Cl Residual Discharged (mg/l)	1995 Plant Max. Ave. Flow (mgd)	1995 Max. Allowed Cl Residual Discharged (mg/l)
1	Vail	12.1	1.5	0.016	1.5	0.016
	Dowds	36.7	2.2	0.032	2.6	0.027
	Avon	36.7	2.5	0.028	4.7	0.015
2	Dowds	36.7	3.7	0.019	4.1	0.017
	Avon	36.7	2.5	0.028	4.7	0.015
3	Vail	12.1	2.7	0.0087	3.0	0.0078
	Avon[2]	36.7	3.5	0.020	5.8	0.012
	Avon[2]	36.7	3.5	0.020	3.5	0.020
	Squaw Ck.[3]	36.7	-	-	2.3	0.031
4	Avon	36.7	3.5	0.020	3.5	0.020
	Squaw Ck.	36.7	-	-	2.3	0.031

NOTES:

1 Minimum 7-day/10-year low flow (lowest month) (NHPQ, 1975)
2 No new plant at Squaw Ck.
3 Build new plant at Squaw Ck.

SOURCE: CDM Inc., NHPQ (1975)

at the Vail and Avon plants would probably not be capable of meeting the stipulations required in their discharge permits. Adequate disinfection would not be possible without excessive chlorine discharge, and much of the sewage flow will probably not receive any treatment.

Streamflow Alteration -- The wastewater system improvements prescribed by the siting alternatives will affect the present flows in Gore Creek and the Eagle River. As more stream water is diverted for municipal use, the required new or expanded sewage works and interceptors may change the historical return points for this water or the amounts returned at those points. This, in turn, will increase or decrease present flows in certain reaches of these streams.

Projected changes in streamflows predicted for the five site alternatives are based on maximum average daily plant discharges and reflect the difference in conditions as they are at present and as they will be by 1995 with all proposed improvements completed and operating. These streamflow alterations are summarized in Table 27 on the following page.

In Alternative 1, much of Vail sewage would be routed to the Dowds Junction plant; Gore Creek would be depleted by as much as 2.48 cfs at its confluence with the Eagle River. The discharge at this new plant would increase flow in the Eagle River by 1.44 cfs between Dowds Junction and Avon. Below Avon, flows would not change.

In Alternative 2, abandoning the Vail plant and routing all flow downstream for treatment will cause a considerable depletion (4.81 cfs) in Gore Creek. Below the new Dowds Junction plant, stream flows will be as in Alternative 1.

As can be seen in the table, implementation of Alternative 3 would have an almost insignificant impact on the flow of Gore Creek or the Eagle River as far as Avon. However, if a new downstream plant is built near Squaw Creek instead of expansion of the Avon plant, flows will be reduced by as much as 3.57 cfs from the Arrowhead area to Squaw Creek, and greater depletions could occur upstream of Squaw Creek if this area is developed and municipal water withdrawn.

In Alternative 4, Vail will treat and release all sewage flows tributary to the Vail plant with the exception of those generated in Bighorn. This will cause a minimal amount of depletion in Gore Creek and the Eagle River as far as Avon. Below Avon, however, flow reductions will be somewhat higher, as great as 3.57 cfs below Arrowhead with planned development.

Since Alternative 5 calls for no action, the existing lines will be used to their full capacity. The quality consequences on the

TABLE 27

Streamflow Alteration in 1995

Average Daily Flow - cfs

Alternate No.	Gore Ck. Below Vail Tmt. Plant	Gore Ck. At Mouth	Eagle R. Below Dowds Jct. Tmt. Plant	Eagle R. Below Avon Tmt. Plant	Eagle R. Below Arrowhead	Eagle R. Below Squaw Ck.
1	-1.86	-2.48	+1.44	0	0	0
2	-4.19	-4.81	+1.44	0	0	0
3	+0.47	-0.16	-0.26	0[2]	0[2]	0[2]
				-2.02[3]	-3.57[3]	0[3]
4	-0.47	-1.01	-1.19	-2.02	-3.57	0
5[4]	+0.03	-0.59	-0.70	0	0	0

NOTES:

1 Numbers proceeded by "+" are streamflow increases
Numbers proceeded by "-" are streamflow depletions
"0" indicates no change from present conditions
2 No new plant constructed at Squaw Ck. (alt. 3a, 3c)
3 New Squaw Ck. plant constructed (alt. 3b, 3d)
4 Based on capacities of existing interceptors and raw sewage overflow in some locations

SOURCE: CDM Inc.

streams would far outweigh the quantity effects, which are probably nominal.

Further depletion of Gore Creek by 2.48 cfs, 4.81 cfs or 1.01 cfs as projected for Alternatives 1, 2 and 4, respectively, during this critical low flow period, may cause extremely low flows in Gore Creek which may create overcrowding conditions for fish. Physiological stress due to crowding has been shown to be detrimental to trout species. Other potentially detrimental effects of crowding to aquatic organisms include decreased oxygen content and a general degradation of water quality. Because 7-day/10-year low flows in the Eagle River are substantially higher than those for Gore Creek, alternatives causing Eagle River depletions would not create these crowding and/or water quality problems.

As population growth continues within the study area, addition water supplies may be diverted directly from the stream, and regardless of the sewage treatment alternative chosen, this additional water need could result in significant stream depletion. The assessment of this potential impact is presently not within the scope of this environmental statement because of the many options which may exist, but have not been fully evaluated, for providing adequate water supply without significant stream depletion. In some cases, addition water supply systems and storage may provide for adequate domestic water needs and still preserve stream flows and values. Conservation of water use is also a strong alternative to significant depletion of stream flows.

Sludge Conveyance/Sewage Pumping

The following impacts, sludge conveyance and sewage pumping, relate more to the engineering analysis of the alternatives than the biological water quality analyses. Each addresses a specific engineering problem.

Sludge Conveyance -- In each of the alternatives, except numbers 4 and 5, routing of waste activated sludge from upstream treatment plants (Vail, Dowds Junction) to downstream facilities (Avon, Squaw Creek) for processing and disposal is proposed. The sludge will be removed directly from the final clarifiers (at about 5.0 percent solids) and discharged into the interceptor sewer system which, depending on the alternative selected, may also be carrying raw sewage from upstream areas. The sludge will mix with the raw sewage and go through the complete sewage treatment process at a downstream facility. The purpose is to eliminate sludge disposal in the Gore Creek and Upper Eagle River area, where it has been a problem in the past, and to process all sludge in a downstream location where disposal sites or agricultural demand for the material will be more available.

Mixing activated sludge, consisting of carbonaceous bacteria, with raw organic matter causes aerobic biological assimilation and oxidation reactions to occur, provided that free oxygen is available. It can be assumed that these reactions will occur when

sludge is discharged to the interceptors carrying raw sewage. Since the free oxygen level in sewage and sludge is low, it could be depleted, causing septic conditions to occur in the interceptors. This circumstance will only be avoided if sufficient reaeration takes place within the interceptor.

The relatively steep grades of the sewers should provide better than normal reaeration potential. The depletion of oxygen in a sewer atmosphere is normally insignificant; however, the access to and availability of sufficient air (oxygen) may be limited by the use of water-tight manholes and by lack of space when the sewers are nearly full. The cold sewage temperatures encountered in the winter will retard the biological reactions greatly, thereby lessening the oxygen consumption. However, for some alternatives, it seems fairly certain that septic conditions will be created, even during the winter since organic loading is greatest during this time.

Septicity in long sewer lines is not uncommon. Anaerobic conditions are present to some extent in most sanitary sewers, but when a sewer becomes highly septic, the following characteristics must be considered:

- Sulfates in the wastewater may be reduced to sulfide gasses, which are highly odorous at lower concentrations, and toxic at higher ones.

- The sulfides in septic sewage are corrosive to some metals, and can attack concrete pipes.

- During activated sludge treatment, sulfides in the sewage may encourage the formation of filamentous sludges, which are difficult to settle.

- Highly anaerobic sewage may require increased aeration capability at the treatment plant.

Among the proposed site alternatives, the interceptor areas most likely to experience septicity due to injection of waste activated sludge into the lines are:

Alternatives 1 and 2:	Directly below the Dowds Junction Treatment Plant.
Alternative 3:	Directly below the Vail Treatment Plant.

In all cases, the mixture will become more diluted as flows proceed downstream. Anaerobic conditions in sewers are common, and septic sewage causes no critical problems in treatment, although some odors may be present and extra aeration may be needed.

Sewage Pumping -- Pumping of raw sewage is usually avoided, due to power costs and the abrasive effect on pump mechanisms. Currently, wastewater collected in the Arrowhead subdivision is pumped back to the Avon treatment plant. With Alternatives 1, 2 and 3a,c, all future Arrowhead flows will need to be pumped back to Avon (unless a downstream plant were built as part of a separate project). If a downstream plant were built in 1985, sewage from Arrowhead would be pumped back to Avon only until 1985 (Alternatives 3b,d and 4).

Noise

In recent years, the effects of noise on the wildlife within a developing area and upon human inhabitants have received more intensive study. Although an exact definition of what constitutes noise has not been determined, it has come to mean "unwanted sound." Noise classifications, termed "levels of annoyance" are somewhat arbitrary since they vary with specie and individual. Table 28, on the following page, gives the various noise levels for people which will cause effects such as hearing impairment, sleep interference, annoyance and physiological stress. To establish the effect of noise from any source, total noise levels must be considered. Construction projects are normally composed of five steps each with noise characteristics caused by the mixture of equipment. These five phases with their typical ranges of noise levels are given in Table 29, following Table 28. These levels take ambient noise in suburban/urban areas into account. In Vail ambient levels would probably be closer to suburban, except in the vicinity of I-70. The location of future proposed facilities on river terraces and along the valley floors will not necessitate the removal of bedrock or any blasting activity. Individual equipment noise during construction will range from 70-100 decibels. However, composite noise pollution levels may reach levels between 100-108 decibels with average levels of between 84 and 89 decibels. These levels, while typical of public works construction sites, will cause annoyance and possible hearing impairment if continued over extended periods of time.

The impact from noise during treatment plant operation is expected to be minor, since the facilities will be enclosed, and exterior noise levels will be very low.

Archaeology, Paleontology and Historic Sites

Since each alternative recommends construction in areas which have been excavated or disturbed in the past, no potential impacts

TABLE 28

NOISE LEVELS AND THEIR VARIOUS EFFECTS ON PEOPLE

EFFECTS	Moderate Level[1] of Risk (dBA)	Appreciable Level of Risk (dBA)
Hearing Impairment	70	90
Speech Interference	45	60
Sleep Interference	40	70
Annoyance	40	60
Task Interference	55	75
Physiological Stress[2]		

NOTES:

1 Probability that the effect will occur

2 Affected by quality, frequency, indivdual sensitivity, time of day and nature of the exposure.

SOURCE: U.S. EPA. 1971. Noise from Construction Equipment and Operations, Building Equipment and Home Appliances.

TABLE 29

TYPICAL RANGES OF NOISE LEVELS AT CONSTRUCTION SITES

Phase of Construction	Suburban Residential[1]		Urban[2]		
	I[3]	II[4]	I[3]	II[4]	
Ground Clearing	84	84	84	84	Ave. noise (dBA)
	8	8	6	7	Std. deviation
	103	104	100	101	Noise pollution level
Excavation					
	88	78	89	79	Ave. noise (dBA)
	7	3	6	2	Std. deviation
	106	86	105	85	Noise pollution level
Foundations					
	88	88	88	88	Ave. noise (dBA)
	8	8	8	8	Std. deviation
	108	108	108	108	Noise pollution level
Erection					
	79	78	79	79	Ave. noise (dBA)
	9	11	3	4	Std. deviation
	103	108	88	88	Noise pollution level
Finishing					
	84	84	84	84	Ave. noise (dBA)
	7	8	6	6	Std. deviation
	101	104	100	100	Noise pollution level

NOTES:

[1]Suburban residential area's typical ambient noise level of 50 dBA

[2]Urban area's typical ambient noise level of 70 dBA

[3]I - All pertinent equipment present at site

[4]II - Minimum required equipment present at site

SOURCE: U.S. Environmental Protection Agency. 1971. Noise from construction equipment and operations, building equipment and home appliances.

are expected to artifacts or finds. If artifacts were to be uncovered, even in a pre-disturbed area, a negative impact would not be likely, however adequate mitigation measures would then be required to ensure that nothing of archaeologic value is destroyed.

Future improvements associated with Alternatives 3b,3d and 4 involve pipeline excavation and building of facilities in areas of previously undisturbed soils. Disturbance of ground along a river in an alluvial valley represents a potential negative impact since the general area is likely to have contained either a camping site or a settlement for the various Indian tribes which inhabited the area. Executive Order 11593 and Section 106 of the National Historic Preservation Act would apply. Selection of future improvements is not anticipated before 1982-1983.

IMPACTS OF GROWTH ASSOCIATED WITH WASTEWATER FACILITIES

It is estimated that during the period between 1975 and 1995 the permanent population of the study area will more than double with the average daily population up by approximately 250 percent. The Avon/Beaver Creek and Arrowhead development areas are projected, under this 201 study, to accomodate nearly 80 percent of this 20 year growth projection. In contrast, permanent population within the Vail/Gore Valley area is projected to increase only about 20 percent with average daily population increasing by around 35 percent by 1995.

From a land development perspective, conversion of land from its present undeveloped state or semi-developed state (grazing, etc.) to commercial, residential or public use will occur to the greatest extent in the Beaver Creek, Avon and Arrowhead areas. These development areas encompass in total approximately 3500 acres, most of which has not been developed (see Figure 12). In the Gore Valley, less than 400 acres are projected to be developed within the next 20 years, with much of this future development in filling between presently developed areas.

Clearly, the nature and extent of secondary impacts associated with the projected population growth and land development within the study area are largely tied to the expected development of the Beaver Creek and Arrowhead ski areas and the adjacent Benchmark and Eagle-Vail areas. These secondary impacts were evaluated in the Forest Service's Final Environmental Statement for Meadow Mountain and their Environmental Analysis Report for Beaver Creek Recreation Area. In these environmental studies, the Forest Service recognized that, "The secondary effect related to the development of a winter sports area are considerably more significant and controversial in comparison to the effects of the remainder of the proposed action." For that reason, the Meadow Mountain Final Environmental Statement contained an evaluation of

the principal secondary and direct impacts within fifteen major areas of concern. Their findings from both studies are summarized in Table 30 on the following pages. Since completion of the Meadow Mountain Statement and the Environmental Analysis Report, the Forest Service, with agreement from the State of Colorado, has issued a permit for use of federal lands in developing the Beaver Creek ski area. Also, many of the necessary approvals for development of Beaver Creek, Benchmark, Eagle-Vail and Arrowhead have been given by Eagle County. Since the secondary impacts of the projected growth has already undergone an extensive evaluation and governmental approvals have been given, secondary impacts are not treated here in depth. If more information on secondary impacts than contained in Table 30 and other portions of this Statement on air quality, urban runoff pollution, etc., is needed by the reader, he or she is referred to the U.S. Forest Service Final Environmental Statement for the Meadow Mountain Planning Unit and the Environmental Analysis Report, Beaver Creek Winter Sports Site and Year Around Recreation Area.

Relationship Between Treatment Works Planning and New Development

The preferred alternative provides for upgrading of the Vail plant and expansion and upgrading of the Avon facility. Because these plants are interconnected, with the latter accepting flows beyond Vail's capacity, treatment plant location (insofar as the area from Bighorn to Avon is concerned) does not exercise an overriding constraint on developmental patterns. Stated another way, within the projected population, the treatment plant geometry can absorb development almost wherever in the service boundaries it chooses to go.

This flexibility is not intentional, rather, it develops from technical and cost-benefit considerations in plant design and operation.

The location of sewage interceptor lines is, from an environmental and engineering point of view, set by preference for (1) gravity flows to minimize costs, (2) use of previously-disturbed sites for environmental reasons, and (3) cost-savings by use of current plant-sites and facilities. Further, the nature of the topography (mountain valleys) influences the location of development and requires that the sewage lines run at, or close to, the valley bottoms. Thus, interceptor location, as such, considering the preference for retaining the Vail and Avon plants, will have only a marginal impact on development patterns.

Interceptor size, on the other hand, can exert a direct impact on development patterns since line segment capacities are directly related to sewered population. However, in the study area, this potential constraint is reduced in effectiveness by the fact that:

TABLE 30

SUMMARY OF IMPACTS AS PRESENTED IN THE FINAL ENVIRONMENT STATEMENT FOR THE MEADOW MOUNTAIN PLANNING UNIT AND THE ENVIRONMENTAL ANALYSIS REPORT FOR BEAVER CREEK RECREATION AREA

Topic	Probable Effects
Availability of Employment Opportunity	Generally beneficial; however, if the New Jersey Mine closes, a certain proportion of the miners will probably not be able to make the adjustment, and will, therefore, be considered unemployable in the recreation industry.
Supply of Permanent Housing	It appears that the county and developers have been able to develop reasonable plans to supply employee housing. The arrangement does not insure that the cost of employee housing will remain reasonable.
Provision of Urban Services	Demand for urban services will increase. There should be concern that the overall delivery of urban services will be fragmented, resulting in greater costs to residents and in levels of service which will vary substantially.
Solid Waste Management	It is estimated that a doubling of the present volume of solid waste will occur within the Upper Eagle Valley. Action has been taken by Eagle County to expand the present sanitary landfill at Wolcott and to study long range solutions for solid waste disposal.
Required School Facilities	The development will provide a favorable impact in the school district, financially, at full development. However, there will probably be a deficit period in the early years unless advanced payments are made by developers as credit against future taxes.
Energy Conservation	The formation of a recreation and support community in the Avon Valley will cause increased demands to be made on the production and distribution of energy. Power requirements will result in further air quality reduction at Hayden and Craig, Colorado where coal fired generating facilities are located to serve the Avon region.
Air Quality	If the Vail experience is to be of any value, local concern should be concentrated on the potential pollution caused by wood-burning fireplaces. Although calculations show that air quality in the Beaver Creek Valley should be maintained within State standards, some air quality degradation is unavoidable. In order to reduce air pollution, the Beaver Creek Recreation

Table 30 (continued)

Topic	Probable Effects
Air Quality (continued)	Area land use plan includes: (1) a mass transportation system designed to serve the major concentrations of density; (2) Parking facilities at the entrance to the property, limiting most traffic to the base of the valley; (3) initially, the maximum allowable number of fireplaces constructed in Beaver Creek shall be limited to 1000 and this limit will be reviewed and adjusted annually based on air quality data and analysis; and (4) a fireplace control plan for restriction of fireplace operation during adverse meteorological conditions.
Water Supply Requirement	It would appear that domestic water requirements will exceed the availability of water from Beaver Creek. In order to preserve the fisheries characteristics of Beaver Creek, the domestic water diversion point will be located near the mouth of Beaver Creek where it enters the Eagle River.
Water Quality And Urban Runoff	Increases in late summer flows from tree removal should not be a significant factor in flooding hazard or channel damage as long as the integrity of the natural waterways is maintained. An increase in rate and volume of surface runoff will be caused by replacing pervious surfaces with impervious surfaces. Detention ponds will be installed as appropriate to hold up turbid water long enough to permit removal of suspended solids.
Water Quality and Sewage Treatment	All projected increases in sewage will be accomodated by the proposed expansion in treatment facilities.
Soil Erosion	Some increase in stream turbidity will be unavoidable during construction of roads, ski trails and buildings which require ground cover disturbance. However, these effects can be minimized by implementing: (1) practices which minimize ground cover disturbance; (2) installation of detention ponds, filters and sediment traps; and (3) prompt revegetation of exposed soil. A riparian buffer zone is also planned to mitigate potential adverse water quality impacts.
Reduction in Scenic Values	In terms of national importance viewing duration and high use volume, the Eagle River Valley bottom is the most sensitive area of scenic quality. Private land developments planned, approved and in some cases under construction, will be the most significant factor affecting visual quality.

Table 30 (continued)

Topic	Probable Effects
Wilderness Suitability	The loss of apparent wilderness suitability on 1,650 acres to be removed from the roadless area and managed for other than back-country values can be considered irreversible. Also, creation of a new population center in lower Beaver Creek mignt place more user pressure on the adjacent Holy Cross roadless area.
Wildlife Loss	Development, related human activity and harassment of deer and elk by free-roaming dogs could result in loss of migration routes and some winter habitat, causing eventual reduction or emigration of herds. However, creation of an "elk enclave" and subsequent habitat improvement activities could result in improved winter conditions for those animals that migrate to the foothills east of Beaver Creek.
Lowering the Quality of Life	Assuming that the existing character of the Avon area is something worthwhile, the potential adverse effects are typically associated with the change from a somewhat rural character to a more urban-type setting. This is manifested by such conditions as increased population, congestion, additional government control, increased cost of living, and changes in both living habits and employment opportunities.

SOURCE: U.S. Forest Service, White National Forest, Final Environment Statemen Statement for the Meadow Mountain Planning Unit and Environmental Analysis Report for Beaver Creek Winter Sports Site and Year Around Recreation Area

- The lines must be sized to accommodate the peak population (winter), thus providing available capacity for other times of the year

- The line between Vail and Avon must be able to handle Vail raw sewage bypasses and activated sludge and, therefore, would probably be designed with a significant safety factor.

The UEVSD consulting engineers have recommended that a predesign review of interceptor line sizing in relation to specific future contributory areas be conducted.

Thus, in summary, the configuration of the prepared plan system permits a range of development. In fact, the local topography and land ownership patterns are, probably, significantly greater constraints than is the treatment works system.

Wastewater System Construction Staging

Population and land use projections for the study area have been based upon the successful development of the Beaver Creek ski area. They provide little allowance for fringe development and a considerable deceleration in the present growth rate in Vail. The population projections are, of course, subject to a range of error and, as indicated earlier in this report, there can be honest differences in views as to how much and where. The study area's economy is volatile, resting as it does on seasonal recreation. Thus, changes in public tastes and/or the absence of the proper climatic conditions could significantly affect the rate of future development. This, then, leads to a consideration of staging the construction of treatment works required to support growth. The question then arises as to the impacts of staging on facility costs, local planning efforts, and land use.

- The preferred alternative provides for meeting 1985 wastewater treatment works needs immediately and for constructing, in the 1985 time period, additional capacity to meet projected 1995 needs. The treatment capacity for 1995 needs would be constricted either at Avon, or at another site not yet selected. By utilizing, to a maximum, current facilities and minimizing land disruption, the first stage (or immediate) construction program is the most economically and environmentally sound.

- By waiting until the early/mid-1980's to determine the need for 1995 populations, actual out-of-pocket capital costs may not be lessened, but the potential for avoiding excess capacities and for continued coorindation of wastewater and other functional planning is significantly increased.

- Also, by restricting major development to the Vail-Arrowhead corridor over the period of the first stage, the potential for orderly development is enhanced.

AIR QUALITY IMPACTS

In order to calculate pollutant concentrations during future air pollution episodes, worst case conditions for meteorology and periods of peak emissions were assumed. These assumptions, summarized in Table 31,on the following page, were applied to the air quality model previously described. Certain assumptions contained in the model are also given in Appendix C.

Some numerical values were calculated for 1975 and extrapolated to future years based upon the future number of households, fireplaces and future traffic projections. The worst case simulation box model was run for a 24 hour period, with emission factors entered into each airshed every hour. Wood-burning rates were entered from 6:00 p.m. to 12:00 a.m. and spaceheating rates every hour. Traffic rates are a daily average, even though actual rates per hour differ. Train rates were entered during assumed hours when a train would be passing through an airshed.

Particulates

Total contributions in kilograms per day from each source during the simulation are given in Table 32, following Table 31. As shown in this table, total contributions from fireplaces ranged from 64-96 percent of the total.

Table 33, following Table 32, summarizes the simulation model results for 24 hour average particulate concentrations, by airshed. The simulation indicated that particulate concentrations will be fairly low in all airsheds during the day, rising sharply after 6:00 p.m., when fireplace emissions are entered. Particulate emissions continued to rise until shortly after midnight when fireplace emissions are assumed to cease (extinguishing fires caused a brief rise in particulate emissions).

One drawback of the model is its inability to simulate long-term peak conditions. The frequency of the condition cannot be determined, nor arithmetic or geometric mean values.

The following observations were made concerning the current and predicted trends for suspended particulates during worst case conditions (assumed to occur at least once per year):

> 1975: Analyses of present air quality conditions show Vail Village and West Vail airsheds above the federal and state standards. (This is partially

TABLE 31

SUMMARY OF ASSUMPTIONS FOR WORST CASE SIMULATION MODEL CALCULATIONS.

Category	Assumptions
Meterology	- Stagnation condition exists on regional (macroscale) level.
	- Wind direction is upslope from 10 a.m. to 4 p.m. and downslope the rest of the time.
	- Wind speed is 0.6 meters per second during downslope phase and averages 1.9 meters per second during upslope conditions.
	- Mixing height of 92 meters is defined by a temperature inversion -- mixing height follows terrain and is constant during all hours of the simulation.
	- An ambient temperature of -5°F is used only in fuel consumption calculations.
	- Meterorological conditions are the same in all airsheds during the stagnation condition.
Emissions	- Emissions of total suspended particulates are representative of a typical winter season peak day.
	- Emissions due to fuel consumption are constant for 24 hours and represent 100 percent customer usage.
	- Train emissions are entered for only 8, 10 or 12 hours of the simulation, the exact number dependent upon year.
	- Emissions from fireplaces are constant between 6 p.m. and midnight and zero for all other hours. A total of 90 percent fireplaces are assumed in use during the evening hours.
	- Traffic emissions for any given hour are proportional to the percentage of the total daily traffic that occurs during that hour.
Model	- Pollutant dispersal is limited by the model boxes. The dimensions are defined by airshed length, average width and an inversion height. The cross-section of an airshed is represented by a trapezoid.
	- The total mass of particulates is conserved -- settling is ignored.
	- Mixing is instantaneous -- the pollutants are thus uniformly distributed within the airshed volumes.
	- Three valley configurations are used with no inter-valley pollutant transport.
	- During upslope winds, 10 percent of the pollutants leaving the Avon airshed are transported into the Beaver Creek airshed and 90 percent enter the Dowd-Avon airshed.
	- Negligible background concentrations of carbon monoxide and total suspended particulates are assumed.
	- The simulation is run for 24 hours -- 6 a.m. to 6 a.m. the next day.

SOURCE: Marlatt and Associates, 1976.

TABLE 32

TOTAL CONTRIBUTION OF SUSPENDED PARTICULATES FROM EACH SOURCE DURING THE 24 HOUR WORST CASE SIMULATION

Year	Airshed	Total Suspended Particulates: Wood Burning	Space Heating	Traffic	Trains
		(kilograms per day)			
1975	Bighorn	177.1	3.6	9.6	-
	East Vail	99.4	1.3	13.6	-
	Vail Village	805.7	40.6	32.9	-
	West Vail	486.0	6.5	25.4	-
	Minturn	101.5	2.8	6.1	2.3
	Dowd-Avon	34.6	.3	10.6	2.3
	Beaver Creek	-	-	-	-
	Avon	-	1.6	9.4	2.3
	Avon-Edwards	-	.3	9.3	2.3
1980	Bighorn	246.2	4.9	14.5	-
	East Vail	105.8	1.3	17.0	-
	Vail Village	844.6	42.7	37.2	-
	West Vail	645.8	8.6	32.1	-
	Minturn	131.8	3.5	7.0	2.8
	Dowd-Avon	131.8	.8	16.3	2.8
	Beaver Creek	116.6	-	2.9	-
	Avon	205.2	4.6	19.9	2.8
	Avon-Edwards	-	.3	12.6	2.8
1985	Bighorn	326.2	6.2	17.2	-
	East Vail	157.7	1.4	19.5	-
	Vail Village	1408.3	44.3	40.9	-
	West Vail	838.1	19.7	40.0	-
	Minturn	216.0	10.7	7.7	3.4
	Dowd-Avon	360.7	3.8	22.6	3.4
	Beaver Creek	656.6	2.2	7.0	-
	Avon	810.0	12.4	33.0	3.4
	Avon-Edwards	239.8	.3	17.3	3.4
1990	Bighorn	393.1	7.5	19.6	-
	East Vail	164.2	1.5	21.8	-
	Vail Village	1466.6	46.1	43.3	-
	West Vail	1004.4	13.0	46.3	-
	Minturn	226.8	4.0	8.3	3.4
	Dowd-Avon	481.7	3.0	28.5	3.4
	Beaver Creek	879.1	-	9.8	-
	Avon	1086.5	16.7	43.8	3.4
	Avon-Edwards	479.5	.5	21.9	3.4

TABLE 33

TOTAL SUSPENDED PARTICULATES, 24 HOUR AVERAGES

AIRSHED	1975	1980	1985	1990
	micrograms per cubic Meter			
Bighorn	67	90	119	141
East Vail	98	120	162	190
Vail Village	261	287	445	480
West Vail	388	457	670	743
Minturn	30	63	270	218
Dowd-Avon	11	36	74	96
Beaver Creek	0	26	151	206
Avon	11	93	317	421
Avon-Edwards	15	82	325	457

Source: Marlatt & Associates, 1976

attributed to the fact that wind direction was calculated as downslope 18 hours per day, including the hours of 6:00 p.m. to midnight. As a result, particulate emissions are drawn into West Vail from the upwind box, Vail Village.) This condition has been monitored in Vail; West Vail has no monitor. All other airsheds are shown below both federal and state short-term particulate standards.

1980: Conditions are similar to 1975.

1985: Analysis shows Vail Village, West Vail, Minturn, Avon, and Avon-Edwards exceeding both state and federal standards, and Beaver Creek and East Vail exceeding state standards. The Avon/Avon-Edwards situations are analogous to Vail Village/West Vail, with emissions from Avon being drawn into the Avon-Edwards airshed.

1990: Vail Village, West Vail, Avon, and Avon-Edwards exceed both state and federal short-term standards, and East Vail, Minturn, and Beaver Creek exceed state standards.

The above observations are indicative of air quality trends in the study area. No conclusions can be drawn from these 24 hour averages as to the frequency and magnitude of the assumed worst case conditions. The assumptions used in the model were best guesses -- and the fireplace use assumptions were particularly high (90 percent from 6:00 a.m. to 6:00 p.m.). The Colorado Department of Health accepted fireplace use assumptions in a Vail Associates study of 50 percent from 6:00 p.m. to 9:00 p.m., 75 percent from 9:00 p.m. to midnight and 25 percent from midnight to 3:00 a.m., when ashes are smoldering. (In this study, the emission factors used for fireplaces were nearly 50 percent higher.) As a result of the identification of fireplaces as a major source of particulates, the Colorado Department of Health will require regular emissions testing in the Beaver Creek area (soon after the initial development phase), and the Town of Vail is conducting a fireplace use study in 1976-1977 as a precursor to a fireplace emissions study which may be conducted in 1977-1978.

Carbon Monoxide

The simulation box model was utilized to calculate CO emissions from vehicular traffic, trains and household fuel consumption. Vehicle emission factors were calculated using EPA circular AP-42. The results of the simulations showed higher eight hour average concentrations in 1975 and 1980, sharply declining in 1985 and 1990. Increasing traffic volume was shown on the whole to be outweighed by the decrease in emissions factors in future years. Since fireplace data for CO could not be calculated, it is impossible to quantitatively determine the future impact decreases in CO emissions from vehicles may have on CO.

IMPACTS ON WATER QUALITY FROM NONPOINT POLLUTION

The purpose of this section is to discuss the influence that the projected population increases and land use changes will have on nonpoint contamination of surface and groundwater in the study area. No new classifications of nonpoint pollution will be created, but the impacts of the existing types may be increased or decreased.

Urban Runoff Pollution

The projected new housing and recreation facilities will have considerable effect on stream contamination through runoff from urban sources, such as streets, parking lots, and rooftops. A majority of the existing developments and the projected growth areas are situated along Gore and Beaver Creeks, which are considerably smaller in size than the Eagle River. Urban runoff pollution is more harmful to the creeks due to their more limited capacity.

The values shown on Table 34 on the following page, represent urban pollutant loadings which could be discharged to Gore Creek during a rainfall event of .1 inch depth and 1 hour duration. The values are estimates, and may be excessive since the research was based on a typical urbanized area which has land-use characteristics of 75 percent residential, 5 percent commercial, and 20 percent industrial. Many of the contaminants, particularly lead, copper, and zinc, can be toxic to a uatic life. Although the values are rough estimates, they demonstrate that pollution from urban runoff could be highly detrimental to water quality (runoff from Eagle-Vail and the Benchmark vicinity will be less detrimental due to the greater dilution capabilities of the Eagle River).

Increases in sediment loadings from further urbanization can be expected due to the fact that approximately 99 hectares (243 acres) of irrigated land will be converted to urban uses.

Road Maintenance

The development of new housing and recreation areas will require construction of many new streets and roads. During the winter, sand and road salt will probably be applied to many of these roads at the same rate and frequency as is the present practice.

TABLE 34

ESTIMATED POLLUTANT LOADING ON GORE CREEK FROM URBAN RUNOFF AND WASTEWATER TREATMENT AT VAIL, COLORADO, 1995

Parameter	Urban Runoff Load[1]	Expected Waste Treatment Plant Average Discharge[2]
	(Parts Per Million)	
Settleable and Suspended Solids	352,000.0	10.00
BOD	1,062.0	8.30
COD	2,530.0	9.50
Kjeldahl Nitrogen	165.0	1.70
Phosphates	90.0	.50
Lead	115.0	.03
Cadmium	0.2	.001
Nickel	2.0	.01
Copper	6.6	.03
Zinc	27.0	.16
Iron	1,563.0	10.40

SOURCE: Sartor and Boyd, 1972; Pitt and Amy, 1973

NOTES:

1 lb/hr for 1 hour storm of .1 inch depth (rounded to the nearest tenth) for a town with the same population as Vail in 1995.

2 lb/hr from Vail (rounded to nearest hundredth; Cadmium to nearest thousandth).

The State Highway Department applies 4 percent salt/sand mixture to roads at the average of 3300 lbs. per mile of highway lane. Applying this data to the total road miles expected to exist in 1995, an estimate was made of the amount of salt which would be used. Assuming 20 storms, and two 4 percent salt/sand applications on all roads per storm, approximately 500 tons of salt could be discharged to the Eagle River and its tributaries per year. (As a comparison, runoff from irrigation in the Gunnison Valley contributes over 1 million tons of salt per year to the Colorado River drainage.)

Sludge Disposal

The disposal of sludge through landfilling creates potential pollution to groundwater or nearby surface water. This practice is currently utilized by Vail treatment plant and is proposed for all future sludge generated by both the Vail and Upper Eagle Valley Sanitation Districts. Lack of adequate or economical sites for drying beds (and subsequent agricultural use) requires that disposal by landfill be employed. New landfill sites have not been selected, but such sites must be well removed from the developed areas for aesthetic and economic (land cost) reasons.

The effect that sludge disposal will have on water resources will be highly dependent on the geographical location of the landfill sites, as well as the soil types, water table location, method of landfilling used, and the nature of the sludge. Some soil types are very conducive to percolation, while others are less permeable and may contain clays and minerals which provide ion exchange and absorption capacity. Alkaline soils may cause some sludge constituents to precipitate, and nutrients will be taken up in plant life. The soils in the study area are mostly clays and loams with moderate to low permeability. Their pH is generally neutral, and they are fairly well suited for landfill sites. However, many of these valleys lie within areas currently inhabited or projected for development. The soils of the upper stream valleys and mountain slopes are loamy to sandy-loamy. Suitability of these soils for landfill sites is fair to poor, since permeability is relatively high, and there is the potential for groundwater contamination. Since new sludge landfill sites will probably be located in these areas, preventive measures should be taken (e.g. locating sites away from water courses and areas of high water tables, and digesting and dewatering the sludge before it is landfilled).

Sludge digestion reduces degradable organic (volatile) materials renders the sludge more concentratable, and greatly decreases the coliform and disease organism content. Digestion is recommended, and often required, when the sludge is to be used in agriculture. Although digestion is not currently employed at the Vail plant, it is recommended in the 201 plan for all future sludge generation. (See Table 35, on the following page, for chemical composition.)

Construction

Construction activity will be heaviest in the Avon/Beaver Creek area, moderate in the Gore Valley, Minturn and Arrowhead areas and very low in the vicinity of Red Cliff. Approximately 16,560 new living units will be built, 93.5 Km (58.1 miles) of highway and secondary roads will be constructed and 292 ha (720 acres) of ski, hiking and equestrian trails will be cleared. Such large scale disturbances, even though projected to take place over a 20-year period, will result in significant nonpoint pollution from construction activity. The most significant impact from these activities on the aquatic ecosystem is expected to come from increased sediment loads on into the area's surface waters. Increases in dissolved chemicals and turbidity will have significant impact on the Upper Eagle River ecosystem, including a reduction. Non-point pollution from construction will be worse during the next few years when activity is expected to be greatest. Once roads and storm sewer lines have been installed and areas have become revegetated, surface runoff from these areas will be greatly reduced.

TABLE 35

TYPICAL CHEMICAL COMPOSITION OF RAW AND DIGESTED SLUDGE

	Raw Primary Sludge Percent of TS [1]	Digested Sludge Percent of TS [1]
Total dry solids (TS, percent)	4.0	10.0
Volatile solids	65	40
Grease and Fats	6-30	5-20
Protein	25	18
Nitrogen	2.5	3.0
Phosphorus	1.6	2.5
Iron	2.5	4.0
pH	6	7
Alkalinity (mg/l $CaCO_3$)	600	3000
Organic acids (mg/l HAc)	500	200
Zn (zinc) [2]	.17	.07
Pb (lead) [2]	.07	.10
Cd (cadmium) [2]	.036	.007
Cu (copper) [2]	.07	.05

SOURCE: Metcalf and Eddy, 1972; Sopper and Kardos, 1973

NOTES:

[1] TS = Total dry solids content (all values in terms of percent of TS except where noted)

[2] averaged values

IV MITIGATION MEASURES

Mitigation measures are those actions which are either planned to be, or which could be, incorporated into the project plan. They usually apply to the primary construction and operation impacts within the direct control of the sanitation districts. Most of the biological mitigation measures recommended will be incorporated into the design, construction and operations stages of the proposed action. Since the revegetation program has not yet been prepared, it is not certain whether each measure will be followed exactly as delineated in this chapter.

However, the consulting engineers have planned a comprehensive revegetation program and intend to design interceptor routes to avoid the destruction of trees and natural vegetation types. Since no mitigation measures are recommended for geology and soils due to lack of impacts, this category has been omitted from discussion.

Other mitigation measures are not within the direct control of the sanitation districts since they relate to secondary impacts associated with growth and development. These include other diversion projects (hydrology), population, land use, and air quality. Implementation of mitigation measures within these impact areas, so as not to incur unacceptable secondary impacts, generally requires co-ordination of various governmental agencies within differing jurisdictions. Such co-ordination and mitigation will be required by EPA if impacts are significantly adverse. A brief discussion of current mitigation efforts is presented as an introduction to other possible mitigation measures which may be pursued and followed. (Mitigation measures for noise and archaeological resources are implementable and are therefore discussed as such although falling within the social mitigation measures category.)

BIOLOGICAL MITIGATION MEASURES

Vegetation

The major impacts on the riparian and lowland meadow communities will be caused by physical disruption and/or removal of plant life during construction. The impact on local vegetation communities due to physical disruption is an unavoidable adverse impact associated with the proposed action. The adverse effects can be minimized by containing construction activity to as limited an area as possible and by employing a thorough revegetation program. Development of a revegetation program prior to commencement of construction, and the inclusion of this program as part of the construction contract, will ensure its implementation.

A successful revegetation program depends upon re-establishment of plant communities similar to those present prior to construction. Detailed description of existing flora on the interceptor alignment or at other construction sites prior to construction should be documented by using local experts (e.g. county extension agents) and/or photographic documentation.

Mitigation measures which will create a suitable micro-environment for plant growth and which will aid in the establishment of a soundly revegetated community are:

- Careful pre-planning of pipeline alignment (location in areas of good, deep soil) where the new lines are paralleling existing lines.
- Avoiding steep slopes and areas of high erosion potential.
- Stockpiling of topsoil to spread over the refilled trenches or other disturbed soils.
- Avoiding large trees and dense vegetation in areas of new construction.
- Rapid refilling of trenches and initiation of revegetation efforts.
- Using mulch material to increase success of seed establishment while minimizing soil erosion.
- Reseeding with a seed mixture including grasses, forbs and, in some cases, shrubs (depending on the community disturbed) to aid in the establishment of a more diverse, natural community.
- Minimizing the number of stream crossings, where possible.

The probability of germination and growth of plants in seeded areas is greatly increased if seed is drilled into the prepared seedbed rather than broadcast over it. Seeded species should be adapted to the site conditions and, to minimize the environmental impacts, native plants should be used. The re-establishment of desirable species in disturbed areas would be enhanced by reseeding the disturbed areas with desirable grasses, forbs and shrubs. Recommended species include grasses such as timothy, tall fescue, smooth brome and reed canarygrass, and forbs such as sweetclover, cicer milkvetch, birdsfoot trefoil, white clover, pacific aster and lewis flax; and a few shrubs such as golden currant, woods rose, black chokecherry, rubber rabbitbrush and brush cinquefoil. In some locations, it may be desirable to include an introduced perennial species such as crested wheatgrass which will produce rapid cover and minimize erosion.

Wildlife

Impacts on local wildlife, due to disruption or removal of habitat, are unavoidable adverse impacts of the proposed action. Mitigation measures to minimize impacts on local wildlife are largely associated with the establishment and implementation of the revegetation program.

Specific mitigative measures which will be utilized to minimize the impact of construction activities on wildlife include:

- Minimizing the construction which will occur within riparian habitat. When disturbance is necessary, the destruction of woody vegetation, especially trees, will be kept to a minimum.
- Limiting the width of the pipeline corridor, so that the least amount of habitat will be disturbed.
- Employing erosion control techniques to prevent silting of waterways and damage to habitat.
- Revegetation of all disturbed areas.
- Using selective clearance of areas (placement of pipeline in areas that will least affect wildlife such as roadsides or lowland meadows).
- Backfilling as much of the open trench as possible each day in order to prevent pitfall hazards to wildlife.

The following mitigation measures may not be readily employed, due to the length of the construction period in cold climates where the ground is generally frozen from November to April. However, their implementation would further reduce adverse impacts to local wildlife.

- Limitation of construction activity to the time of year (August to March); when wildlife are not breeding or carrying young.
- Limitation of construction activity to late in the year (August to March) when annual vegetation has fully developed, thereby allowing for maximum forage and habitat for wildlife.

Aquatic Biota

Impacts on the aquatic biota due to construction activities in or near Gore Creek or the Eagle River are unavoidable adverse impacts. Rapid degradation of water quality resulting from selection of Alternate 5 is an unavoidable adverse impact associated with the no project alternative. The primary mitigation actions which will control impacts on the aquatic biota during construction involve the control and proper maintenance of construction equipment, and a water quality control plan, which should be developed prior to construction activities and incorporated into the construction contract negotiations. Public Law 92-500, Section 404, requires that a permit be applied for in all areas where stream crossings will occur. This will be done 90 days prior to construction.

Colorado law requires that construction activities must limit their induced stream turbidity to less than 10 Jackson turbidity units (JTU's) (induced turbidity is that turbidity above the natural condition of the stream). The contractor will coordinate with the Colorado Water Quality Control Division in order to ensure that increased turbidity is minimized where possible. The salient features of a good water quality control plan are:

- Careful preliminary planning of construction with special emphasis on avoiding in-stream or near-stream disturbances.
- When in-stream activities are required, the time of heavy equipment activity should be minimized.
- Pre-construction selection of refueling and equipment storage locations away from area waters.
- Minimization of vegetative disturbance in areas adjacent to streams or other areas of high erosion potential.
- Rapid revegetation of disturbed soils.
- Preventive maintenance of construction equipment, especially fuel and oil reservoirs.
- Phasing of near or in-stream construction activities to avoid continuous suspended sediment loading.
- Avoiding suspended sediment loading during the time of year when local fish are spawning (the predominant spawning species is brown trout, which spawn from late September to late October).
- Utilize catch basins and settling ponds to retain highly turbid or fuel contaminated waters produced in side channels, backwaters or from adjacent disturbed land.

PHYSICAL MITIGATION MEASURES

Control of Urban Runoff Pollution

While the subject of this environmental statement is not control of non-point sources of water pollution, consideration must be given to all pollution sources, especially in developing areas, if effective water quality management is to be realized. Non-point pollution controls can generally be categorized as source abatement measures, cleaning practices and treatment methods. These three categories are discussed in general terms below. The suitability of application of these non-point water pollution controls to the study area will differ, in terms of effectiveness and acceptability, from the already developed areas, such as Vail, to the proposed developments in the vicinity of Avon. Structural controls, usually associated with treatment, are most easily and effectively implemented during construction and continued as a planned element of the development. Non-structural controls, such as ordinances against litter and excessive erosion, can be instituted in existing urbanized areas. The Northwest Colorado 208 water quality management plan will be addressing non-point source control in greater detail and should contain specific recommendations for Eagle County.

Although the accumulation of a certain amount of street surface contaminants in an urban environment is inevitable, much of the litter that reaches the street and sidewalk can be eliminated, or at least effectively controlled at its source. This direct approach to reducing the runoff pollution potential can best be accomplished through active public education and through effective and enforceable regulations and ordinances relating to outdoor cleanliness. In addition to the general anti-litter ordinances, specific regulation should be directed towards the most prevalent sources of litter in the urban environment, such as, garbage and refuse collection, building construction, vacant lots, parking lots and garages, pet control and food handling establishments.

Street surface contaminants, which represent a major portion of urban land contaminants, can be partially removed by street sweeping operations prior to being exposed to runoff. Municipal street cleaning practices may be improved by increasing the frequency of street sweeping and/or increasing the removal effectiveness of street cleaning methods.

The treatment of urban stormwater runoff has been approached in two major ways over the past several years. One approach is storing the peak flows and discharging them to conventional treatment plants during low sewage flow periods. The second approach is to utilize specialized storage and treatment processes to deal specifically with quantities and types of pollutants found

in storm water runoff. The surface storage pond is by far the most frequently proposed method of storing runoff. Use of such ponds should be considered in the planning of storm drainage systems for new communities as they will reduce the peak flows of runoff resulting from urbanization and can also provide erosion and sediment control for the area during the construction phase of development. If properly designed, use of pervious vegetated areas for drainage of impervious surfaces can also be utilized on new communities with similar beneficial effects in reducing peak flows and in controlling sediment.

Water Conservation

The relatively high per capita water use (125-150 gal./capita/day) now being experienced within the study area combined with the reality of limited water supplies and the potential for stream flow depletion suggests that water conservation be considered as a mitigation measure. Conservation of in-house water use would also have benefits in terms of wastewater treatment capacity requirements.

In the study area, major water use volumes are associated with the seasonal winter resort skiing activity. Recognizing that most of this seasonal water demand is caused by visitors who rent apartments and condominiums, their water consumption is probably insensitive to reasonable variations in cost. However, increasing water rates may increase consideration of modified water using equipment, such as toilets, showers, and washing machines, that use less water.

Plumbing fixtures have been designed which reduce water use without causing inconveniences to the user. It is estimated that the average shower requires 35 to 40 gallons of water and that automatic flow regulation can reduce this use by about 50 percent. Toilet fixtures are available which reduce the amount of water by more than one-half (from about 8 gallons per flush to 4 gallons), an important savings, since toilets account for about 45 percent of all water used in the average household. Dishwashers and clothes washers are being redesigned to substantially reduce the rinse water now required. In general, appliances and fixtures now available can reduce total water use in the average household by as much as 35 percent.

If water and sewer charges are not an adequate incentive to encourage users to install water-saving appliances and fixtures, revising municipal plumbing codes to require installation of certain of these devices in all new construction and replacement in existing units may be needed to achieve adequate water conservation. Within the study area such action could include local building code revisions requiring water saving fixtures and fittings in new construction, and in all remodeling projects. Additionaly, a concentrated public relations program on water conservation might be initiated.

Future Water Diversion Projects

There are currently two large transmountain water diversion projects in the planning stages, Eagle Piney/Eagle Colorado and Homestake II. The projects and estimated annual diversions were given in Chapter II. Expected effects could not be determined due to sparse distribution of gauging stations, and lack of data concerning diversion periods and rates. The water rights of both projects are relatively junior, due to their late adjudication dates. Consequently these projects present no probable harm to most other appropriators. Diversions made under junior rights must usually be made during the heavy runoff period, spring snowmelt. (Homestake I is allowed to divert only from April to August.) During diversion periods, the demand of senior diverters downstream will help ensure that streamflow is not depleted by water exportation. In Colorado, municipal water use is considered a preferred use over irrigation, and in times of storage, a municipality may invoke this privilege to obtain water out of priority. However, this preference of use is not self-executing, but must be exercised by condemnation and the payment of compensation to the non-preferred user. Therefore, under normal circumstances, both projects may divert only within their priority.

Maintaining adequate flows to support fish life will also help to insure that streamflows are not depleted to an undesirable level. As of 1973, Colorado statutes provide that water may be appropriated for the purpose of maintaining adequate fish-flows. New decrees may be adjudicated or existing rights may be purchased and a transfer of use made for this purpose. Recommendations for minimum flows are made by the Colorado Division of Wildlife to the Colorado Water Conservation Board. Such a procedure has not yet been undertaken on the Upper Eagle River or its tributaries. Should this tool be used, the purchase of water rights senior to those of the exportation projects would be necessary to insure that their diversions were regulated for preserving fish flows. Recommendations have been made for Gore Creek and are contained in Table 36 on the second following page.

Diversions made on government lands or for government-funded projects may be regulated through written agreements with the affected agencies. The right-of-way agreements between the Homestake I project and the BLM include certain stipulations relating to limiting diversion periods and maintaining minimum streamflows, as recommended by the U.S. Fish and Wildlife Service for preserving fish habitats. Regardless of legal priority or water availability, these minimum flows must

be maintained through or around all diversion or storage structures of the Homestake I Project, or they must petition and pay damages.

Although such written agreements have not yet been formulated for the new diversion projects, they will probably contain similar stipulations.

TABLE 36

MINIMUM STREAMFLOW RECOMMENDATIONS
BY COLORADO DIVISION OF WILDLIFE
FOR SUPPORTING FISH HABITAT

STREAM	MINIMUM FLOW (cfs)
Pitkin Creek	3
Booth Creek	3
Red Sandstone Creek	4
Gore Creek	5[1]
Gore Creek	7[2]
Gore Creek	7.5[3]
Black Gore Creek	9
Bighorn Creek	3.5
Beaver Creek	
May 1 - Sept. 30	12.0
Oct. 1 - April 30	4.0

[1]Headwaters to Black Gore Creek
[2]Black Gore Creek to Red Sandstone Creek
[3]Red Sandstone Creek to Eagle River

SOURCE: Colorado Division of Wildlife

SOCIAL MITIGATION MEASURES

Social mitigation measures are those related to population growth and land use, air quality, noise and archaeologic, cultural and historic sites.

Population and Land Use

Growth is expected in parts of the study area— new growth in Avon/ Beaver Creek and expanded growth in Vail and Minturn. Various efforts to control growth in the United States have not been completely successful, although the rate of growth has been slowed by such methods as imposing excessive utility tap fees, a moratorium on new taps due to a lack of treatment facilities, and restrictive zoning covenants. In the study area, wastewater treatment facilities will not prevent development from occurring, since alternative methods of treatment could be sought by developers, resulting in a proliferation of small plants or package plants.

One mitigation measure for reducing high rates of growth is down-zoning, which will reduce future population density. Vail is currently pursuing a growth management plan. Although data is unavailable as to the methods which will be recommended, it is probable that down-zoning will continue to be one method, justified through a facilities/services analysis, which discloses the financial impacts to the community.

In the future, restrictive zoning could be applied in the area surrounding Beaver Creek to confine development and prevent scattered development patternsand consequent per capita increases in the costs associated with some facilities, e.g. sewer lines.

Any zoning changes proposed in an area from a less restrictive to a more restrictive category must be considered in consultation with the owners of the land. Otherwise, these changes could be contested. The Federal courts have ruled that down-zoning may be interpreted as a taking, without compensation, and cannot be enforced.

Future land use policies and controls will essentially be the responsibility of the Eagle County Planning Commission and County Commissioners in cooperation with local units of government who control local zoning. The past development patterns at Vail may provide an impetus to exert more County control in the Avon/Beaver Creek area.

Air Quality

Vail has been identified as a potential problem area for air quality problems and has received some attention in the mitigations area. The Town of Vail is conducting a pollution testing program and a fireplace use study. Next year, it is hoped that a fireplace emissions study will be conducted in order to assess the magnitude of emissions from this source and the potential impact that any of the following measures would have in reducing future air quality problems. Vail has an on-going program of reducing auto emissions through the use of auto-free zones and restricted parking to enhance and maintain a pedestrian oriented community.

The following mitigation measures for fireplaces and mobile sources were drawn partially from the Town of Vail's suggestions. They are intended as a possible shopping list from which a future emissions control program may be drawn.

Fireplaces-- These mitigation measures may be taken individually or in combination with other strategies to limit fireplace emissions.

Fuel Storage

Description: Require firewood to be stored in outside storage areas or in basement areas.

Advantages: No direct research or cost associated with the program.

Disadvantages: Difficult to obtain cooperation of lodge owners and difficult to enforce.

Effectiveness: If inconvenience of obtaining fuel were great enough, a portion of emissions could be reduced.

Timing: Implementation within one year given no legal objections.

Legal Authority: Local ordinance passed by Town of Vail Council and/or County Commissioners.

Public Acceptance: Negative response due to inconvenience of visitors.

Transfer of Fireplace Rights

Description: Similar to transfer of development rights; a developer would be able to transfer an allocated number of fireplaces to another airshed providing it did not adversely affect that airshed.

Advantages: Reduce potential emissions in airsheds with high particulate concentrations.

Disadvantages: Will only redistribute sources, and put the burden on future developments.

Effectiveness: Extensive modeling would need to be conducted before effectiveness could be evaluated.

Timing: Implementation within two to three years.

Legal Authority: Local ordinance by Vail Town Council and/or County Commissioners.

Public Acceptance: Negative response from dvelopers -- no response from the general public.

Zoning Density Reduction

Description: Through zoning procedures a development desiring fireplaces would have its unit density reduced according to the number of fireplaces desired. For example, for each fireplace in a development, one dwelling unit would be eliminated.

Advantages: Would severely restrict numbers of new fireplaces constructed in the Gore Valley.

Disadvantages: The burden would be placed on the future developments.

Effectiveness: The number of sources could remain at near present levels so that concentrations would not become much worse.

Timing: Implementation within two years without legal objections.

Legal Authority: Local ordinance passed by the Vail Town Council and/or County Commissioners.

Public Acceptance: Negative response from the developers; no major response from the general public.

Phase-Out

Description: Declare a moratorium on building any new fireplaces.

Advantages: No research or direct cost associated with implementation.

Disadvantages: Decline in skiing vacationers due to a loss in aesthetic enjoyment; places entire burden of air quality maintenance on future developers.

Effectiveness: Eliminates a significant percentage of future particulate emissions but fails to control existing emissions in Gore Valley.

Timing: Implementation feasible within one year assuming no legal obstacles.

Legal Authority: Building codes passed by the County Commissioners and/or Town of Vail Council preventing developers or homebuilders from constructing fireplaces.

Public Acceptance: Little response since this measure would not have an immediate impact on existing residents; major response from prospective residents and developers.

Fuel Conversion

Description: New or existing fireplaces would be required to either burn natural gas or use electric power.

Advantages: Aesthetic enjoyment would be semi-retained.

Disadvantages: Unfeasible considering the current "energy crisis" and short supply of natural gas.

Effectiveness: Eliminates a significant portion of the particulate emissions while adding only a negligible amount of new emissions.

Legal Authority: Local ordinance passed by the County Commissioners and/or Town of Vail Council.

Timing: Dependent on the availability of natural gas and electric power.

Public Acceptance: Negative response since the cost of natural gas or electricity would be higher than the present cost of wood and loss of aesthetics.

Fireplace Controls

Description: Require particulate control equipment to be installed on existing and new fireplaces.

Advantages: Allow woodburning fireplaces while controlling emissions at the source.

Disadvantages: Indirect cost of research and development of control equipment and direct cost of installation and maintenance.

Effectiveness: Assuming a 90 percent control efficiency, a significant percentage of the particulate emissions would be eliminated.

Timing: Dependent on the length of research and development and prototype testing (approximately three to five years).

Legal Authority: Local ordinance passed by the County Commissioners and/or Town of Vail Council.

Public Acceptance: Negative response due to the economic burden on the individual condominium, home or lodge owner.

Emission Allocation

Description: Allow the maximum number of fireplaces and associated emissions in an airshed that would not cause the particulate NAAQS to be exceeded.

Advantages: Development would be distributed into each airshed so as to allow fireplace use while maintaining the NAAQS.

Disadvantages: Land ownership and zoning may prevent redistributing development and the county has approved future development location.

Effectiveness: Balance particulate emissions with the assimilative capacity of the ambient air to maintain NAAQS but create additional mobile source emissions (CO & HC) due to longer travel distances.

Timing: Implementation would be contingent upon the successful relocation of planned developments using emissions as a constraint.

Legal Authority: Changes in the Eagle County Master Plan and possible state intervention (Land Use Commission) to prevent planned development densities and locations previously approved.

Public Acceptance: Little response since this measure would not have an immediate impact on existing residents but major response from prospective residents and developers.

Special Operating Conditions

Description: Woodburning or fireplace usage would be prevented during poor dispersion conditions and require a seasonal meteorologist employed by the county (also meteorological stations).

Advantages: Applied only during the time it is needed and allows fireplace usage during good dispersion conditions.

Disadvantages: Difficult to enforce and requires both a public alerting system and "police action" for violations.

Effectiveness: Eliminates a significant percentage of particulate emissions on "worst case" days where citizen cooperation is essential.

Timing: Implementation feasible within two years assuming no legal obstacles.

Legal Authority: Local ordinance passed by the County Commissioners and/or Town of Vail Council (apply to AQMA study area, not county-wide).

Public Acceptance: Negative response due to government intervention into public enjoyment.

Mobile Sources-- The following mitigation strategies are directed at mobile sources:

Pedestrianization

Description: Close off local streets and create pedestrian malls.

Advantages: No major costs associated with implementation -- Aesthetic considerations.

Disadvantages: Inconvenience to visitors and locals with possible increased cost of deliveries.

Effectiveness: Reduce CO emissions by at least 25% by reducing low speed traffic, but fails to control any freeway or arterial emissions.

Timing: Implementation feasible within one to five years.

Legal Authority: Ordinance passed by the Town of Vail Council and/or the County Commissioners.

Public Acceptance: Previous attempts have generally had a positive response due to safety, aesthetics, and economics.

Public Transportation

Description: Major bus system operating within the Gore Valley.

Advantages: Reduce auto emissions without major restrictions on driving.

Disadvantages: Direct cost of operating the bus system.

Timing: Increased bus system would be dependent on additional Federal monies which could take two to five years.

Public Acceptance: Positive response due to low cost to public, and general reliability of system.

These ten mitigation measures do not include all possible alternatives. Combinations of two or more of the strategies are possible. For example, fireplaces in lodges could be required to burn natural gas and new residential fireplaces could be required to have emission control devices. Therefore, a weighted combination of strategies may meet the political, legal, and social requirements.

Mitigation selection should not be based solely on maintaining air quality standards but should include many other considerations. Alternatives should be reviewed for their feasibility within the political and legal framework of Eagle County.

Noise

Mitigation measures for noise from construction equipment will include proper maintenance and mufflers. The need for special mitigation measures such as noise buffers will not be necessary.

Archaeology, Paleontology and Historic Sites

The proposed action has been discussed with the staff of the Colorado State Archaeologist. Their view is that the disturbed nature of the project impact area makes conducting archaeological surveys to identify previously unrecorded resources largely impractical, since previous disturbance would likely have destroyed all surficial manifestations. However, if subsurface materials are uncovered, impacting work must be halted until the site is evaluated in terms of the eligibility criteria of the National Register of Historic Places.

Should a site be determined eligible for the National Register, plans for the mitigation or avoidance of adverse impacts must be properly arranged.

The Office of the State Archaeologist recommends that a knowledgeable person be retained during construction to identify potential archaeological resources.

V FINANCIAL CONSIDERATIONS AND IMPACTS

The rates and charges of the Vail Water and Sanitation District and the Upper Eagle Valley Sanitation District have been analyzed for the following:

- Adequacy of present charges to meet future costs.
- Adequacy of present charges to finance the needed sewer line and plant improvements recommended in the 201 Facilities Plan.
- Fairness in terms of each user paying his fair share of the cost of operations and the cost of growth.

The data presented in this document is a condensed version of a more detailed and lengthy financial analysis and rate study presented to the VWSD and UEVSD Boards in January-February, 1977. Numerous detailed financial projections, population distributions, and other supporting information have been omitted for the sake of brevity.

RATES AND CHARGES

Vail Water and Sanitation District

The total estimated cost of the proposed plant and line improvements for Vail is $4,145,000. The 75 percent federal portion of this project is an estimated $3,109,000. An election authorizing a bond issue for the remaining $1,036,000 is recommended for 1978.

In addition, the Vail Water and Sanitation District should adopt a method of computation of tap fees which ensures that each new user will pay his proportionate share of both the present and future capital costs of the plant and system. It is estimated that this would increase sewer tap fees from $150 per unit (10 points) to $540 per unit.

An increase in sewer rates is recommended from $5.75 per unit per month to $6.55 per unit per month.

These increases should be instituted early in 1977. The plant construction and sewer line expansion are only a small portion of the financial need for a rate increase. From 1977 to 1980, a large portion of the bonds attributable to the sewer system will be retired, placing considerable financial demands on the Vail District's revenues.

Upper Eagle Valley Sanitation District

The total estimated cost of the Facilities Plan plant and line improvements for the Upper Eagle Valley Sanitation District is $5,353,000. The 75 percent Federal portion of this part of the project is an estimated $3,962,000.

A general obligation bond issue of $1,391,000 is recommended for 1978 to finance Upper Eagle's improvements to lines and plants. An election authorizing a bond issue for the $1,391,000 local share is recommended.

The present bond issues should be refunded in early 1977 to spread the heavy debt service schedule over the next few years. This refunding measure will net the district an interest savings of $25,000 through 1993, the term of the present bonds.

Tap fees, based upon the principle of proration of capital expenses to each user should be increased from $700 per unit to $800 per unit.

An increase in sewer rates is recommended from $6.30 per unit to $7.90 per unit per month. Inflation, increased debt service for existing debt (even with a 1977 refunding and bond issue) and expansion of the existing plant will contribute to this increase. These rate increses should be instituted in early 1977.

Bighorn Area of UEVSD

This analysis assumes that the wastewater flows produced by the Bighorn area of Vail, currently within the UEVSD, are to be treated at the Vail plant, and a contract for services is to be signed between the two districts.

Prior to contract negotiation, Vail's expenses attributable to the Bighorn area must be apportioned; whether costs attributable to Bighorn should be allocated on the basis of population, units, or flow must be determined; and responsibility for the enlargement of sewer lines through Vail serving Bighorn must be assigned.

Other options to a contract for Bighorn treatment are discussed in Appendix O.

The institutional analysis states that there are no legal obstacles blocking either merger of the two districts, partial consolidation of the Bighorn area into the VWSD, or retention of the status quo.

Upper Eagle-Vail Village West Contract

Tap fees and sewer rates for the Upper Eagle Valley Sanitation District service area are calculated as though all rates and fees could be changed by a unilateral action of the Board. In fact, a contract between the Vail Village West Water & Sanitation District and Upper Eagle freezes the rates and fees charged for sanitation in the Vail Village West service area through 1990.

If these contract terms remain in force, the monthly rate increase for Upper Eagle residents required would be 34 percent instead of the recommended 25 percent. This would mean that instead of increasing rates from $7.90 per unit per month, rates would have to increase to $8.45 per unit per month.

Red Cliff Water & Sanitation District

The Red Cliff sewer system requires significant improvement. Although that community is seeking 100 percent federal funding from other non-EPA sources, the Vail and Upper Eagle Districts should stand ready to include Red Cliff in their grant applications if requested.

NO FEDERAL FINANCING - NO ACTION ALTERNATIVE

On all options 75 percent federal participation in new capital financing has been assumed. This section addresses the impact on the two districts should EPA take "no action" in funding the treatment works.

General Impact

Installation of plant improvements to achieve the quality of effluent probably would not be possible. The bond issue interest costs may be so high that construction of the facilities described in the 201 Facilities Plan might not be possible. Adequate construction capital may not be available. By adding three times the present local capital costs to the projects of the two districts, the credit of either or both of the two districts in the municipal bond markets may be exceeded. Bond buyers may view the projects as unfeasible.

Interest rates, hence cost to the area served, would be higher than the 6.5 percent estimated, if the bond issues were found feasible.

Residents of the two districts might not vote the issuance of general obligation bonds for such a large amount of capital. This would leave the other financing alternative of revenue bonds, which are probably made unfeasible by the addition of three times the present estimated capital costs.

For simplicity, it has been assumed that the Districts could finance the expansion and upgrading of facilities recommended.

An interest rate of 7.5 percent on 20-year general obligation bonds has been assumed, which might be low in reality.

Impact on Vail Water & Sanitation District Rates

Capital costs for the VWSD would increase from $1,036,343 to $4,145,371.

Instead of a service charge increase of 12 percent being needed, the increase would be 45 percent, to a monthly service charge of $8.50 per unit (10 points per month).

Instead of tap fees increasing from $150.00 to $540.00 per unit (10 points), they would increase to $1,175.00. This is an increase of 783%. It is likely that this significant increase in tap fees would reduce the number of taps collected by the Vail District at least for a few years and, therefore, cause an additional increase in monthly service charges as tap fee revenue may fall off.

Impact on Upper Eagle Valley Sanitation District Rates

Capital costs for the Upper Eagle Valley District would increase from $1,391,000 to $5,353,000.

Annual debt service on the new debt for plant and interceptor expansion would increase from $126,000 per year to $525,000 per year. This is a net annual increase of $399,000 and would occur for each of the next 20 years.

Payments to Vail Water & Sanitation District for the capital costs of the Bighorn area would increase by a net of $80,000 for 1978 through 1981.

Payments received from Vail for their annual share of the capital costs of the sludge treatment facility would increase by a total of $33,000 through 1981.

Using the refunding bond option previously recommended to establish Upper Eagle's rates, a sewer service of $10.55 per unit per month would be required.

Tap or connection fees for the Upper Eagle Valley District would have to increase from $700 per single family unit to $1,360 per single family unit. This increase, as in the Vail District, would probably reduce the number of expected units and tap fees, at least in the immediate future, and cause an additional amount of cost to the District to be borne by the sewer and service charges.

It should be underlined that in the case of both Districts, the increase in capital costs caused by a lack of Federal funding very well might cause the two Districts to be unable to issue sufficient bonds to cover project costs, and, hence, make the two Districts unable to accomplish the plant and interceptor improvements necessary for a quality effluent to meet State and Federal standards.

VI IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The loss of valuable natural resources as well as the energy consumption requirements of projects have become a primary concern from an environmental protection/conservation standpoint. Natural resources which will be consumed or utilized in the construction of facilities and in the manufacture of equipment include concrete, steel and other metals, plaster, glass, and wood. Other considerations are land costs, consumption of energy, operation and maintenance costs, abandonment of resources, loss of agricultural production and the replacement frequency for various types of equipment.

Due to the complexity of these and other economic considerations, a gross economic cost/benefit comparison was performed by the consulting engineers utilizing the EPA publication A Guide to the Selection of Cost Effective Wastewater Treatment Systems. The figures, contained in the consulting report, indicate cost comparative numbers rather than specific project cost estimates which cannot be prepared without detailed engineering analyses. Excluding Alternative 4, which did not include any costs for the Vail Water and Sanitation District, the annual costs range from $1,441,000 to $1,567,000 (a range of 8.7 percent). These costs include capital costs and annual operation and maintenance (over an 18 year amoritization period) of: wastewater treatment (primary and secondary), sludge treatment and disposal, pipeline replacement and land costs. The figures generated represent, in terms of the utilization of total resources, energy and materials related, only a comparison. Because they use national average costs, they cannot be related to the study area and its problems (e.g., the difficulty of finding sludge disposal areas near the Vail Plant which necessitated the abandonment of sludge facilities at Vail, or the prohibitive cost of land application in an area with a relatively short growing season). The comparative costs, given as annual figures are:

Alternative	Annual cost $1,000	Percent of Highest Yearly Cost
1 -	1,567	100
2 -	1,513	96
3a -	1,406	89
3b -	1,564	99.8
3c -	1,374	88
3d -	1,441	92
4 [1] -	954	--

[1] Does not include Vail costs.

It is apparent that total reliance upon a cost comparison for

evaluation purposes is not practicable. Also important are the environmental losses (wildlife habitat), growth and possible sprawl, and other issues addressed elsewhere in this report. The no action alternate (5), while requiring no depletion of natural resources or energy, would cause significant degradation of the environment unless growth was limited through a complete building moratorium. Moratoria, however, have been looked upon by the state and federal courts as an unconstitutional means of placing a ceiling on development.

From an energy conservation standpoint, two alternatives require the utilization of more resources, Alternative 2 in which the Vail Plant is abandoned and a new plant built at Dowds, and Alternative 3b, 3d in which a new plant is constructed in the Squaw Creek Area. The Squaw Creek alternative eliminates the costs of pumping Arrowhead flow, but requires new sewer line construction through an area of potential growth and development which is currently rural/agricultural.

In summary, all alternatives will require a significant amount of natural materials and energy in order to maintain high levels of water quality in the future. Each alternative must be assessed in terms of the need to balance some economic considerations with environmental conditions.

VII THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

THE SOCIAL ENVIRONMENT

Expected increases in population levels have brought on the need for wastewater system expansion and improvements. If the duration of the increase was short-term, the long-term benefits for the enhancement and maintenance of water quality would then be questionable. Since the magnitude of future development is as yet undetermined, staging of treatment plant works must address the problem of potential adverse effects from over-capacity, which has been accomplished by the 201 plan.

THE PHYSICAL ENVIRONMENT

Expansion and upgrading of sewerage facilities will remove the land in the vicinity of construction activity from present uses (e.g., wildlife habitat, agriculture and various urban uses). The disturbance will be localized for the most part, within the construction easement. After construction, revegetation will return most land to its former uses, with the exception of small parcels where new plants and expansions occur. Due to the secondary impacts of growth, the long-term uses of an estimated 34 developable parcels will be changed from open space and agricultural to recreational and residential.

THE BIOLOGICAL ENVIRONMENT

The immediate short-term effects of the proposed project, on the biological system of the Upper Eagle River Valley environment, include a loss of vegetation and wildlife. The construction phase of the project will temporarily lower the quality of the aquatic and terrestrial habitat. Preservation and enhancement of habitat quality will ensure the maintenance of existing ecological interrelationships and the continued health of both natural and human components of the ecosystem.

Actions that significantly decrease the quality or quantity of the Eagle River or Gore Creek by either severe ecosystem disruption or by direct contamination will have long-term impacts on future productivity of the ecosystem as well as the health of populations in and adjacent to these waters. Protection of the Eagle River and Gore Creek is critical during construction, and all feasible mitigation measures will be undertaken to prevent any disturbance that is severe or of long duration.

The project represents a significant mitigation measure in the prevention of continued degradation of areawide water quality. The current and potential future problems have been discussed in the water quality section. The continued or expanded use of existing leaching fields and septic systems between Avon and Squaw Creek could be reduced through the provision of extended lines, particularly if a new plant is built downstream.

GLOSSARY

Activated Sludge Principle - Sludge floc produced in raw or settled wastewater by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning floc previously formed.

Aeration - (1) The brining about of intimate contact between air and a liquid by one or more of the following methods: (a) spraying the liquid in the air, (b) bubbling air through the liquid, (c) agitating the liquid to promote surface absorption of air.

Aerobic Digestion - Digestion of suspended organic matter by means of aeration.

Aerobic Digestion Tank - Tank used in aerobic digestion. See Aerobic Digestion.

Alluvial Groundwater - Groundwaters which are hydrolically connected to surface waters but are found in the valley fill deposits (alluvian) adjacent to these waters.

Anaerobic Digestion - The degradation of organic matter brought about through the action of microorganisms in the absence of air or elemental oxygen. Usually refers to waste treatment by fermentation.

Biological Oxidation - The process whereby living organisms in the presence of oxygen convert the organic matter contained in wastewater into a more stable or a mineral form.

Chlorination - The application of chlorine to water or wastewater, generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

Chlorine Contact Chamber - A detention basin provided primarily to secure the diffusion of chlorine through the liquid.

Comminution - The process of cutting and screening solids contained in wastewater flow before it enters the flow pumps or other units in the treatment plant.

Comminutors - Machines used in comminution.

Contact Stabilization - A modification of the activated sludge process in which raw wastewater is aerated with a high concentration of activated sludge for a short period, usually less than 60 min., to obtain BOD removal by absorption. The solids are

subsequently removed by sedimentation and transferred to a stabilization tank where aeration is continued further to oxidize and condition them before their reintroduction to the raw wastewater flow.

Contact Tank - A tank used in water or wastewater treatment to promote contact between treatment chemicals or other materials and the body of liquid treated.

Decibels (dB) - A logarithmic measure of the sound intensity normalized to a reference pressure.

Dewatered on Drying Beds - To extract a portion of the water present in a sludge or slurry.

Facilities Plan - (Also referred to as a 201 Facilities Plan). A plan drawn up under Public Law 92-500 under Section 201. Section 201 authorizes federal construction grants for 75 percent of the planning, design and construction costs of new or improved facilities. Stage One is the Facilities Plan, Stage Two is Design and Stage Three is Construction.

Final Clarifier - (Also referred to as Sedimentation Tank). A unit of which the prime purpose is to secure clarification. If "final" clarifier, it is used in the final clarification stage.

Grit Removal - The heavy suspended matter (e.g. sand, gravel, cinders) present in water and wastewater which must be removed to prevent damage to wastewater facilities. Removal is usually accomplished through the use of grit chambers.

Manual Bar Screen - A manually operated screen used for the removal of coarse floating and suspended solids.

Mixing Depth - The height above the surface through which relatively vigorous vertical mixing of the atmosphere occurs. Normally it is at a minimum during the morning breakup of a nocturnally formed temperature inversion.

pH - The negative logarithm of the hydrogen-ion concentration. The concentration is the weight of hydrogen-ions, in grams, per liter of solution. Neutral water, for example, has a pH value of 7 and a hydrogen-ion concentration of 10^{-}. The scale, whose numbers range from 0-14, with 7 representing neutrality, expresses both acidity (below 7) and alkalinity (above 7).

Primary Clarification - The settling process by which a reduction of the concentration of suspended matter in a liquid is made. If primary, it is done ahead of biological treatment.

Richter Scale - A logarithmic scale for expressing the magnitude of a seismic disturbance (as an earthquake) in terms of the energy dissipated in it with 1.5 indicating the smallest earthquake that can be felt, 4.5 an earthquake causing slight damage, and 8.5 a very devastating earthquake.

Screening - The removal of relatively coarse floating and suspended solids by straining through racks or screens.

Sludge - (1) The accumulated solids separated from liquids, such as water or wastewater, during processing, or deposits on bottoms of streams or other bodies of water. (2) The precipitate resulting from chemical treatment, coagulation, or sedimentation of water or wastewater.

Supernatant - The liquid standing above a sediment or precipitate.

Thickened by Flotation - Thickening by the raising of suspended matter to the surface of the liquid in a tank as scum - by aeration, evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition, and subsequent removal of the scum by skimming.

Vacuum Filtration - Filtration performed with a vacuum filter, consisting of a cylindrical form mounted in a horizontal axis, covered with a filter cloth, and revolving with a partial submergence in liquid. A vacuum is maintained under the cloth for the larger part of the revolution to extract moisture. The cake is scraped off continuously.

APPENDIX A

OTHER FEDERAL WATER QUALITY PROGRAMS

EPA is responsible for the control of toxic substances that may be discharged into the nation's waters through the Toxic Substance Program, which is designed to reduce the effects of toxic chemicals on humans and the aquatic environment.

Other federal agencies that have water quality programs include the U. S. Geological Survey (USGS). Their experience in ground and surface water hydrology is especially helpful in monitoring mineral quality. The USGS is currently monitoring water quality for the areawide 208 program. The Soil Conservation Service of the Department of Agriculture has an erosion control program, which includes reservoir construction. The SCS can advise on land management practices for erosion control.

The Department of Housing and Urban Development administers grants to state and local agencies for the formulation and coordination of community development plans and programs (general plans are commonly known as HUD 701 Plans) The U. S. Forest Service has developed a watershed management monitoring program designed to gather baseline water quality data. These data will be used to determine future effects of silviculture on water quality and to evaluate watershed management methods.

Integration of individual state water quality plans will be coordinated by the Bureau of Reclamation and presented as the Western United States Water Plan. The purpose of this plan is to identify and direct future efforts in satisfying the most critical water quality requirements. The Westside Study teams have conducted a comprehensive study of the existing and future water quantity requirements of the eleven western states.

The Corps of Engineers permit program, Section 13, commonly called the Refuse Act of the 1899 Rivers and Harbors Act, gave the Corps the task of regulating all industrial discharges. Section 10 of the Act is still in effect. (Other sections were repealed with the enactment of new laws, e.g. PL 92-500) It concerns industry in the construction of outfalls and other obstructions in navigable waters. This program requires that a permit be obtained from the Corps of Engineers.

OTHER COLORADO WATER QUALITY PROGRAMS

The Colorado Individual Sewage Disposal Systems Act directs the Colorado Department of Health (CDOH) to adopt minimum standards for the location, construction and performance of these systems. Local health authorities are required to adopt rules and

regulations for individual systems, pursuant to the minimums established by the state. A permit is issued by the local Board of Health when the required data is submitted by the applicant.

Colorado Senate Bill 1963 requires state certification for treatment plant operators, and all wastewater treatment plants must be under the supervision of operators holding proper certification. The certification program is regulated by the plant operators Certification Board of the CDOH.

The Division of Wildlife of the Colorado Department of Fish and Game is currently taking an inventory of certain streams and rivers in the study area to obtain data for making recommendations for maintaining minimum stream flows to support fisheries. Colorado Senate Bill 97 provides that the Colorado Water Conservation Board can appropriate water through the state water law system for the purpose of insuring that surface flows remain adequate to maintain fish life. Appropriations can also be made for maintaining minimum water levels in natural lakes.

Colorado Water Quality Standards

Water Quality Standards for surface waters exist for each classification. All streams are placed into one of four classes, summarized in Table A-1. The Eagle River, Gore Creek, and all associated tributaries are classified B_1.

Proposed Water Quality Standards -- Revised water quality standards are being prepared for Colorado by the Committee on Colorado Water Quality Standards and Stream Classification, Water Quality Control Commission. The new system will classify waters as recreational, aquatic life supporting, agricultural, or water supply. Some classifications have been subdivided (cold water/warm water, groundwater/surface water), with specific proposed water quality standards.

The standards are grouped into categories including physical, pollutional indicators, toxic metals, other toxicants, inorganic minerals, organics (including pesticides), radiological, and biological. The standards will be recommended to the Colorado Water Quality Control Commission for adoption. The proposed classification system and water quality standards are shown on the following six pages.

Wasteload Allocations

Wasteload allocations determine the amount of designated pollutants which can be discharged to a receiving stream without exceeding the

TABLE A-1
SUMMARY OF COLORADO STATE WATER QUALITY STANDARDS[a]

Parameter	Class A1	Class A2	Class B1	Class B2
	Standard			
Settleable solids	free from	free from	free from	free from
Floating solids	free from	free from	free from	free from
Taste, odor, color	free from	free from	free from	free from
Toxic materials	free from	free from	free from	free from
Oil and grease	Cannot cause a film or other discoloration	Cannot cause a film or other discoloration	Cannot cause a film or other discoloration	Cannot cause a film or other discoloration
Radioactive material	Drinking water standards	Drinking water standards	Drinking water standards	Drinking water standards
Fecal coliform bacteria b	Geometric mean; 400-12,000 7-day average 200-6,000 30-day avg.	Geometric mean; 400-12,000 7-day average 200-6,000 30-day avg.	Geometric mean; 400-12,000 7-day average 200-6,000 30-day avg.	Geometric mean; 400-12,000 7-day average 200- 6,000 30-day avg
	"Whatever is necessary to protect the public health in the stream classification discharged "			
Turbidity	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.	No increase of more than 10 J.T.U.
Dissolved oxygen	6 mg/l minimum	5 mg/l minimum	6 mg/l minimum	5 mg/l minimum
pH	6.5 - 8.5	6.5 - 8.5	6.0 - 9.0	6.0 - 9.0
Temperature	Maximum 68°F; maximum change 2°F	Maximum 90°F; maximum change: streams - 5°F lakes - 3°F	Maximum 20°C [68°F]; maximum change; 1°C [2°F]	Maximum 32°C [90°F]; maximum change: streams 3°C [5°F], lakes 2°C [3°F]
Fecal streptococcus	Monthly average of <20/100 ml from five samples in 30-day period	Monthly average of <20/100 ml from five samples in 30-day period	-----	-----

[a]Adopted on 19 March 1974; effective date - 19 June 1974. [b] Variable; a scale is used.

Source: Colorado State Department of Health, Water Quality Standards and Stream Classification, 1974

water quality requirements of the stream. Surface waters are classified as being either effluent limited or water quality limited. The Eagle River and Gore Creek are both water quality limited streams; they cannot meet B_1 stream standards without more restrictive waste discharge limitations than the state standards.

Ammonia toxicity to aquatic life is of primary concern in the Eagle River and Gore Creek. EPA has suggested that a maximum level of .02 mg/l un-ionized ammonia should not be exceeded for waters classified for fisheries use. Based on a .02 mg/l limit, and allowing for temperature, pH and streamflow dilution effects, seasonal ammonia wasteload allocations were determined for Gore Creek and the Eagle River in the 303(e) Plan. Monthly allocations were calculated in a second study prepared for Vail Associates.

Colorado has not adopted an un-ionized ammonia standard, but one has been recommended in the new proposed water quality standards. Ammonia restrictions based upon the recommended limit have been written into some of the latest discharge permits. The discharge permit issued to the Upper Eagle Sanitation District (UEVSD) for the Avon plant contains ammonia discharge limitations based on the above report.

APPENDIX B

Population Projections - Methodology and Definitions

Between 1960 and 1970, Eagle County population increased from 4,680 to 7,500, a total increase of 60 percent. Between 1970 and 1975, Eagle County population was estimated to have increased by 4,000 persons, a 53 percent increase in five years or an 8 percent annual growth rate, compounded yearly.

Each subarea was evaluated separately to establish the pattern for growth in eastern Eagle County during the next 20 years:

First, continued growth within the Vail area is expected, and the nature and magnitude of that growth is currently a source of concern and discussion. (Vail growth will be influenced by both national and local politics, and by the economics within the community as well as within the country and abroad.) The skier capacity of Vail mountain is expected to influence the rate of increase significantly; as the mountain becomes saturated in terms of design capacity, the market for new condominiums should be reduced and the number of skiers may be controlled through marketing or through artificial limitations (e.g., parking, lift ticket reservations).

The second area of potential growth is the unincorporated portion of the Gore Valley, West Vail. This area in whole or in part could be annexed to Vail during the next 5 to 10-year period. The West Vail Homeowners Association is composed of advocates both for and against annexation. West Vail is currently governed by County zoning and zoning exceptions* have been granted for approximately 1200 units. As parcels in West Vail are annexed and zone changes are then granted by the Town of Vail, the current trend has been to "downzone" this area.

Third, the expected development of the Beaver Creek winter and summer recreation area by Vail Associates at Avon will have profound, multiple effects upon growth in the area during a 20-year period. The development period of Beaver Creek may be of shorter or greater duration than Vail. However, Benchmark and Eagle-Vail planned subdivisions next to Beaver Creek have already installed improvements and sold

*A zone exception is a preliminary plan approval granted by the Eagle County Planning Commission.

land, and these two developments can be expected to receive a boost from Beaver Creek development. Thus initial development in Avon could be at an accelerated rate. Other parcels close to Beaver Creek ski area could also be developed within a 20-year span (e.g., Nottingham Ranch). (Whenever the Beaver Creek/Avon area is referred to in this study, the Beaver Creek, Benchmark and Eagle-Vail developments are included.)

Fourth, Arrowhead is a second proposed winter and summer recreation development in the Avon area which has a shared boundary with Beaver Creek. Arrowhead's development is considered to be more speculative than Beaver Creek; however, future favorable economic and market conditions could provide for this third ski area development near Vail.

Fifth, Minturn is a small community which houses many employees of the New Jersey Zinc Mine, as well as some of the employees of the Vail area (an estimated 10 percent of current Vail employees live in Minturn). Much of the developable land around Minturn is owned by Vail Associates. Future development possibilities for the Minturn area are speculative and will depend upon: (a) provisions for a demonstrated economic benefit for Minturn residents, and/or (b) a change in the political atmosphere. Minturn has recently downzoned within the city limits to prevent dense development (e.g., motels) from locating there.

Sixth, Redcliff is far removed from recreational development pressure and will remain a small community. Redcliff will probably attract only a few transient construction workers employed elsewhere during the next two decades.

Seventh, the rural parts of the County will not grow appreciably due to the current restrictions on the use of septic tanks, and current land use legislation which protects mountain areas in particular.

The final decision as to methodology for population forecasting was made after an examination of current methods being employed in recreation areas and in areas of rapid growth in the Rocky Mountain region. The proposed methodology was discussed with Council of Government, County, State and local planners, and with practitioners, consultants who previously developed projections for Aspen, Steamboat Springs and Craig, Colorado. The approach employed the use of assumptions which resulted in a range of low, medium and high figures, corresponding to the assumptions developed through interviews with those who have local knowledge about changes likely to occur during the next 15 years.

Projects not mentioned in the population projections which could impact the Gore Valley and Upper Eagle Valley were:

- expansion of the Eagle County airport
- development down Upper Eagle valley toward Edwards and Wolcott
- the Iron Mountain Dam and the expansion of Homestake Reservoir
- the Adam's Rib Ski Area proposed near Eagle
- expansion or depression of the U.S. ski industry
- expansion or depression of the demand for summer resort areas in the mountains
- continuance of presidential visits
- the attraction of many industrial and manufacturing concerns to the area
- location of educational and cultural facilities in Vail
- a depression in the national economy
- further delays in Beaver Creek development due to financing or to environmental interests
- a local political atmosphere which is anti-growth
- an energy crisis which would affect travel, access and mobility

Any major change in the given assumptions given in Tabular form in the existing environment section of the EIS could be monitored and measured against these background conditions.

Definitions and Ratios Utilized in the Population Estimates

The following definitions pertain to winter season unless stated otherwise.

Peak Day: A peak day is defined as any average weekend day during December and January. (Peak peak days are weekend and holiday days at Christmas, New Years and Washington's Birthday.) Source: Town of Vail and Vail Associates.

Occupancy: The number of persons staying overnight in a unit, calculated in terms of beds/unit. An average of three beds per unit exists in Vail. Occupancy rates in Vail were utilized in projecting occupancy rates in the Beaver Creek and Arrowhead areas. Winter average occupancy rates in Vail are: 80% for those units which are under a central booking agency, or a hotel or lodge (highly managed units) and 65% for those units which are under the management of a resident manager, owner or small agency. Peak occupancy in Vail is 90 to 95 percent (all units); in Beaver Creek and Arrowhead peak occupancy was estimated at 85% to account for the relative newness of the areas and competition from Vail. Source: Johnson memoranda, V.A., Town of Vail and Vail Resort Association.

Average Visitor Population (overnight): Equal to the number of units times average occupancy.

Peak Visitor Population (overnight): Equal to the number of units times peak occupancy, 85% or 95%, depending upon area.

Day or Short-Term Visitor Population: Present Vail Associates estimates are that 3-4,000 out-of-town short-term visitor skiers are in Vail on any winter weekend day. No data exists for weekdays; however, weekday skier population was estimated to be one-sixth of weekend visitors. In estimating the winter average day visitor population one-fourth the weekend day total was utilized for totaling average daily population. Source: Vail Associates automobile/parking lot surveys and CDM.

Permanent Population: Permanent population equals the number of jobs times average number of persons per job (in the Vail area 1.8 - 1.9 in the winter and 2.2 per job in the summer). Source: The John Ryan Company, State of Colorado Division of Employment. This ratio is low due to the high number of singles and young people attracted by seasonal recreational employment.

Peak Day Population: Equal to the peak day visitor population (overnight and day or short-term) plus the permanent population.

Average Daily Population: Equal to the average visitor population (overnight and short-term) plus the permanent population.

Day Skier to Visitor Skier Ratio: The day skier to visitor skier ratio on weekends is estimated as 1.2. (One-third of those on the mountain are day skiers, out-of-town or locals.) In this report, the number of day skiers has not been consistently recalculated to conform to present ratios due to the following: as the number of skiers on the mountain rises to the level at which the peak day capacity is exceeded more often than 9% of the time, the number of day skiers could decrease or regulations or disincentives may be imposed (see mountain capacity). Several alternatives exist to Vail or Beaver Creek in Summit County -- areas which have declined recently in day skier population and which could be expected to recapture a larger share of the day skier market. Source: Vail Associates, Colorado Ski Country, Forest Service. CDM ratios used are the author's judgment.

Skier Visitor to Non-Skiing Visitor Ratio: For every two long term visitors who are on the mountain, there is another visitor who is not skiing or a non-skier but who is staying in lodging; an average of two-thirds of all visitors are skiing daily. Source: Vail Associates. Real estate and data analysis by CDM.

Peak Skier Population: Equal to two-thirds of the overnight visitor population, plus the total estimated weekend day skier population. Source: Town of Vail, V.A. data and analysis by CDM.

Visitor Population to Employment Ratio: The visitor-to-employment ratio in Vail averages 3 - 3.5 long-term visitors (average) per job. Generally, these ratios tend to be lower during the first few years of development and may also reach a level where the incremental gains in visitors do not generate new jobs. In Beaver Creek, the Vail ratios were utilized; however, the final visitor to job ratio is estimated at 4.8:1 due to the conservative developer estimates of numbers of jobs generated. (It should be kept in mind that the basic and service job ratios may change; for instance, if the Beaver Creek area has fewer condominium accommodations and more lodge/motel units, then the total number of service jobs would rise due to increases in restaurants.) If the shopping center at Beaver Creek is successful as a regional center, a higher number of basic jobs per visitor will result. The ratios are a combination of developer estimates, present ratios and the author's judgment. Source: V.A., Ron Allred and CDM.

Mountain Design Capacity: (Design Day and Peak Day) Mountain capacity is the number of skiers per day which can be accommodated by the combination of ski lifts, ski trails and access roads of an area (e.g., at Beaver Creek 13 lifts, 38 miles of trails and 15 miles of access roads equal a design capacity of 7500). Design capacity is related to vertical lift feet and mountain size. A design day is defined as the 15th highest day on the mountain, usually when design capacity is reached. When actual skier use exceeds the design capacity, a peak period is reached. A peak day of 20% more than design capacity is considered safe by the Forest Service and is allowable for 15 total days per 156 day season (9.6%). As stated in the Forest Service use permit, Beaver Creek may exceed 7,500, or design day, 15 days of the season (up to 9,000). If the design day is exceeded more than 15 days per season, then V.A. and the Forest Service will "work to establish a use control system." Source: V.A. draft EAR and Forest Service interviews.

Market Absorption Rate (Real Estate): The market absorption rate for condominium and second home sales in units per year. The current rate in Vail has been 200 - 300 units per year for the past 4 to 5 years. (When lodge units are included, Vail has experienced an average total absorption rate of 400 units per year in 14 years of development.) This rate is dependent upon the economy and national recreational demand trends. Source: V.A. and real estate interviews.

Summer Employment (Vail): Equal to approximately 70 percent of winter employment.

Summer Population (Vail -- permanent): Equal to approximately 87 percent of winter population.

Summer Visitor Population (Vail): The John Ryan Company estimates an average of 1100 visitors per day, but the summer peaks and valleys of visitor population are much wider than the winter. (Conventions usually come in late summer/early fall; May and October are months when nearly everyone leaves.) An analysis of sales tax returns, summer occupancy rates and bus ridership suggests that the summer visitor population is 30 - 40% that of winter, depending upon month.

Population Allocations: An estimated 80 percent of Vail's winter employees currently live in the Vail area (50 percent in Vail and 30 percent in West Vail) and 20 percent live in Minturn, Avon, Eagle, Gypsum and rural areas. There will be employee housing (an estimated 1200 units) provided in the Beaver Creek/Avon area at full development. The employee exchange between Vail and West Vail employees living in Beaver Creek and Beaver Creek employees living in Vail will probably offset one another. Therefore, 85 percent of Vail and Beaver Creek permanent populations were allocated to remain at their place of employment, 10 percent were allocated to Minturn, 5 percent to communities outside the boundaries of the study area (80 percent of Arrowhead employees were allocated to that base area). Source: The John Ryan Company, Town of Vail, and Colorado Division of Employment Security; data analysis by CDM. (Employee housing data supplied by Benchmark, Vail Associates and Eagle-Vail; Arrowhead Development would add another 400 employee units to the area.)

Vail and the Gore Valley

Vail Village, developed as the business core, also supports high density condominium and lodge development. Pressure

from businesses desiring zoning conversions in the core is being placed on the town council and planning commission. Many of the buildings built in the 1960's do not conform to present building codes. The renovation and renewal of older buildings could be economically dependent upon zoning exceptions. Higher densities might be permitted to encourage needed renewal or upgrading given a demonstrated economic need.

The market absorption rate for new units in Vail has been an average 200 - 300 units per year for the Vail area (past 5 years). An oversupply between 1973 - 1975 was caused by several factors: in 1973 an ordinance was proposed which would have downzoned all developments causing some developers to proceed ahead of schedule; the second-home market fell in 1972-73 due to the recession and new tax laws.

The second Vail commercial core is at Lionshead. This area is presently evaluated as under-utilized in terms of total occupancy due to particularly low summer use, and to the high number of units which are privately owned and not available as high occupancy rentals. A second factor may be the lack of successful marketing of this area for conferences.

The Bighorn area in east Vail, recently annexed, is an area of low density, with many large single family homes, duplexes, and some multi-family condos. Densities are expected to remain low due to a more severe climate, less access, and topography and avalanche hazards.

The West Vail area, which is unincorporated, is an area with many undeveloped parcels, although there now exist a number of large condominium developments, single family and duplex type homes. In December, 1975, the Lionsridge area of West Vail was annexed to Vail and downzoned. Currently, the County has voted for zone changes to permit at least 1200 units to be built in the West Vail area based on preliminary plat approval. If West Vail is annexed, in part or as a whole, downzoning is expected to occur.

In addition, as peak mountain capacity is reached on more than 15 season days (that which is allowable under the Forest Service permit under which ski areas operate), two questions will be addressed:

1. How to market the low season, November through mid-December and April for more timely and efficient use of the mountain.

2. Will a reservation system for ski-lift tickets be necessary in order to prevent the saturation of the mountain? (The Forest Service is committed to dealing with this problem with the developer, Vail Associates, as soon as mountain design day capacity is exceeded more than 15 season days.)

The condominium market itself may regulate Vail growth and prevent the kind of overbuilding which would promote skier regulation. One assumption that was fairly consistent in all of the Vail growth projections -- no high growth rates were predicted for the Vail area; somewhere between 1,200 - 3,500 new units were projected to be built within the next 15 to 20 years.

The Beaver Creek/Avon Area

Currently, the Avon area is sparsely populated by an estimated 600 residents, many of whom work in Vail. The area has been the subject of many recent studies due to the proposed Beaver Creek ski area development by Vail Associates. Subdivisions exist with improvements and some buildings. These developments would receive a growth impetus when Beaver Creek is developed. Benchmark has begun construction of a regional shopping center; a bowling alley and theater are planned for this summer. Eagle-Vail has built a golf course and both have already constructed units.

Each growth profile for the Beaver Creek/Avon area included the development of Beaver Creek as a ski area due to recent state and Forest Service approvals. The start-up development year and final projected number of units vary as well as the anticipated annual rates of growth.

The success of Beaver Creek as a ski area is dependent upon continued expansion of recreational skiing demand, especially destination skier demand. Vail has averaged an annual 18 percent increase in demand during the past 5 - 10 years, which is only partially related to mountain expansion. During a period of recession in the U.S., and during an energy crisis, the demand for destination skiing has risen steadily in Colorado and the West. Part of this increase may be attributable to skiers who changed from vacationing at European ski resorts to ski areas in the U.S. after dollar devaluation; however, some of the increase is due to an influx of new skiers as skiing becomes accessible to a larger segment of the population. (Both these conditions could be subject to peaking or declining.) Some market surveys for the future demand exist. Both positive and negative growth has been projected; therefore, the future is speculative. The current attitude of the state, the investment houses and the Forest Service is one of caution as compared to the attitude of 10 years ago. A use permit has been granted by the Forest Service for the Beaver Creek Ski area; therefore population projections are made for the Beaver Creek/Avon area based upon ski area development.

Beaver Creek/Avon development will influence the rate of growth in Vail, and the existence of Vail and the Vail growth experience are expected to influence the development of Beaver Creek. The present situation in Vail, the oversupply of condominiums coupled with an "unbalanced mix" of condo-apartments to motel and lodge space, may significantly affect development in Beaver Creek. The development of lodges and motels could be more desirable near the beginning stages of the Beaver Creek with base area condo development following at a slower pace. In Benchmark and Eagle-Vail, far more condominiums than lodge unit development is planned. These development plans could change as the most profitable markets emerge. Although the Beaver Creek Ski area will begin at a more accelerated pace than Vail, due in part to the growth which has already occurred in the area, the growth curve is expected to flatten out over a longer period of time, hopefully avoiding an oversupply of units.*

Arrowhead

For the purpose of population projections, Arrowhead has been considered separately from the Beaver Creek/Avon projections. While both Benchmark and Eagle-Vail rely upon Beaver Creek as an economic determinant in terms of skiing, the master plan for the Arrowhead area includes a ski development with a 4800 skier design capacity (per day) a golf course in each phase (a total of two) and equestrian trails and stable. At this time, many people consider Arrowhead much more speculative than Beaver Creek. The developers themselves insist that development will begin very soon. For these reasons, the suggestion to consider Arrowhead separately was followed.

Arrowhead has been planned in two phases: phase 1 will have 2700 units (965 employee, 1275 high occupancy and 460 low occupancy units); phase 2 is platted for 600 units, 180 employee, 300 high occupancy and 120 low occupancy units.

Minturn

Minturn is a small mining community 1.7 miles south of Dowds Junction and 7 miles southwest of Vail. Today the Minturn Valley is populated by some 1500 persons although less than half live in the town. Many of the residents work at the New Jersey Zinc Mine; others, the more recent residents, work

*The development of Meadow Mountain at Minturn as a beginner area was not considered because of V.A.'s stated preference to make a land trade with the Forest Service.

in Vail (an estimated 10 percent of Vail employees live in Minturn). Sixty to seventy-five percent of the Minturn area population is Spanish speaking.

Between 1900 and 1930 Minturn population stabilized at approximately 400 persons. By 1940, the population grew to 596, and between 1940 and 1950 another 165 individuals were added to the census. During the 10 years from 1960 to 1970, another 44 individuals moved to the community. The Valley, however, grew by more than 100 percent, from a few hundred to 800 or more (figures for the Valley are somewhat indefinite due to the aggregation of the rural population). It is estimated that during the past 5 years Minturn has added 260 more people totaling 960, a 7.2 percent average annual growth rate for 5 years.

The population in Minturn is expected to grow when Beaver Creek is developed due to the immigration of employees. Although Vail Associates (V.A.) is committed to local recruitment, training and local employment where possible, many newcomers will be seasonal employees and not dependent upon year-round employment.

Minturn population projections reflect the influence of both Vail and Beaver Creek. The future of Minturn is more certain than either recreation area. Possible influences, some of which are currently having an effect upon Minturn are: local concern over rapid growth (downzoning has recently occurred), possible closure of the New Jersey Zinc Mine (which has been discussed for the past 10 years), annexation policies, acceptance of V.A. employment by locals and employee housing demands from Beaver Creek. The growth assumptions for Minturn were based upon present trends; however, one factor which was impossible to assess was the present and evolving political attitude.

Table 4 on the following page gives a breakdown of permanent and transient population for Minturn based upon the assumptions presented in the population section of the EIS.

Red Cliff

The community of Red Cliff is approximately 16 miles southwest of Vail and 9 miles south of Minturn. This area is one of sparse population; about 650 residents live in Red Cliff. Red Cliff began as a mining community and today many of the residents work for the New Jersey Zinc Mine. (The population is 53 percent minority (Spanish surname) with approximately 80% of the surrounding population classified as minority.) Since 1910, Red Cliff population has fluctuated. Between 1910 and 1940 Red Cliff grew from 240 to 715 population.

declining to 585 by 1960. Since 1960, Red Cliff has grown to 621 residents which represents an average yearly increase of only .59 percent. The population has not been significantly influenced by Vail growth.

Red Cliff is not expected to attract many of the employees of the Vail area because of its relative isolation. Construction workers may elect to live this distance from Beaver Creek during the initial development stages. This will depend in part upon the provision of inexpensive housing near the project site. If Beaver Creek or Vail growth were to affect Red Cliff, the population impact would be minimal, since commuting time is similar to communities with more amenities.

Another possible growth influence would be the Iron Mountain Dam project which is part of Phase II of the Homestake Project. This project would serve the City of Aurora and Colorado Springs. Project construction is projected to begin between 1980-83. Crews would be as large as 300 men during summer peaks. Only two growth projections were made for Red Cliff. The area could gain or lose population depending, as Minturn, upon a possible closing of the New Jersey Zinc Mine. Since Minturn's population is not broken into visitor/permanent/transient groups, no detailed breakdown is presented in this appendix, figures are contained in the existing environment section of this report.

APPENDIX C

AIR QUALITY

Assumptions and Procedures

This appendicized data gives the background for some of the assumptions found in the body of the report for fuel consumption, fireplaces, vehicle use, and meteorology. These data relate to emissions and worst case assumptions.

Fuel Consumption

Data regarding fuel consumption came from several sources. The 1975, rather than 1974, data were utilized, although fuel consumption was two percent less in 1975. Fuel consumption by airshed was calculated by using average household use times number of households. Daily use (winter) was calculated as 70 percent of total use divided by the number of days from November to April (period when 70 percent consumption occurs). Fuel consumption by airshed for 1975 is shown in Table A-2. The emission rates used are in the body of this report. The assumed worst case condition, for space heating, was -5° F, when most furnaces would be in continuous or 90 percent use. Future planned developments intend to utilize all electric units; no polluting fuels will be used. Future increases in household fuel use, by airshed, was deemed nominal, and calculated only in areas presently served.

Wood Burning Fireplaces

Fireplace emission factors obtained from an EPA sponsored study of residential fireplace emissions in Seattle, Washington, were the only data available. Tests using pine were utilized for particulate emission factors, and those using Douglas Fir were utilized for CO factors. The CO factors were run using the box model and were found to be too high to be valid -- thus CO emissions for fireplaces were not calculated for future years for the study area.

Calculations for numbers of existing and new fireplace units were

TABLE A-2

1975 FUEL CONSUMPTION

AIRSHED	NATURAL GAS (10^6 cubic feet)	LP GAS (10^3 gallons)
Bighorn	46.5	8.8
East Vail	15.5	6.7
Vail Village	524.4	60.7
West Vail	82.5	23.8
Minturn	32.5	30.0
Dowd-Avon	-	38.0
Beaver Creek	-	-
Avon	-	200.0
Avon-Edwards	-	38.0

SOURCES: Public Service Company, Williams Energy Company

Daily Natural Gas Consumption = (number of natural gas customers) X (22.5 ft.^{3}/dwelling unit/degree-day) X (70 degree-days)

[1]EPA published APTD-1135, 1973
[2]Each degree below 65°F represents one degree day, -5°F = 70 degree days

developed using the present and projected number of units, by type and by airshed, in the study area. This data was developed, in part, during the population projections analysis. Dwelling units were designated single family, multifamily, or lodge units, either according to zoning (Vail) or developer preliminary plats (Dowds-Avon) or present ratios (Minturn). Each single family duplex or multifamily unit was assumed to have one fireplace. One fireplace per 25 lodge units was assumed. Present and projected numbers of units and fireplaces are given in Table A-3.

Population and dwelling units were converted into growth factors in future years by airshed. These growth factors were utilized to estimate future emission rates whenever no other sources of data were available, as in natural and LP gas consumption in areas presently served.

Vehicles - Mobile Sources

Traffic data and calculations of total vehicle miles travelled (VMT's) and average daily traffic (ADT) are components of the traffic emissions data. Peak day traffic volumes were used to represent a worst case. Peak day emissions from highway sources were converted to hourly emissions using hourly traffic breakdown for the area. Average daily traffic figures for freeways and arterials are given in Table A-4 on the following page. These figures represent number of miles of road by type, in each airshed, multiplied by average daily traffic and typical peak day traffic volumes. These figures were used in developing emission rates. Traffic for a typical peak day is 1.15 ADT for freeways and arterials. Local peak traffic was obtained from ADT using average to peak population ratios. Average traffic counts were taken by Town of Vail and The John Ryan Company. Future estimates for freeway and arterial traffic in the Upper Eagle Valley came from the Colorado Division of Highways. Hourly traffic estimates were used to estimate percent of total emissions to enter, by hour. These percentages are given in Table A-5.

These assumptions when combined with the emission ratios given in the body of the report, resulted in the current and projected emission rates given in Table A-6.

Meteorology

Worst case conditions for wind direction and speed were obtained from Vail mechanical weather station data. Selected days with definite downslope and upslope wind patterns and apparently little large scale influence were analyzed. Hourly wind speeds and directions most conducive to pollutant buildup were averaged

TABLE A-3

DWELLING UNIT AND FIREPLACE PROJECTIONS

Airshed	Single Family	Duplex	Multi-Family	Lodge	Other	Total Units	Total Fireplaces
			1975				
Bighorn	59	64	277	24	-	424	401
East Vail	40	-	182	100	-	322	226
Vail Village	92	14	1665	1136	-	2907	1816
West Vail	63	195	834	48	-	1140	1094
Minturn	226	-	-	125	-	351	231
Dowd-Avon	75	-	-	-	25	100	75
Beaver Creek	-	-	-	-	-	-	-
Avon	-	-	-	-	230	230	-
Avon-Edwards	-	-	-	-	-	-	-
			1980				
Bighorn	81	88	382	34	-	585	553
East Vail	42	-	191	105	-	338	238
Vail Village	97	15	1743	1187	-	3042	1903
West Vail	83	259	1109	64	-	1515	1454
Minturn	289	-	-	159	-	448	296
Dowd-Avon	22	88	187	-	-	297	297
Beaver Creek	-	72	180	290	-	542	264
Avon	-	43	413	171	42	669	463
Avon-Edwards	-	-	-	-	-	-	-
			1985				
Bighorn	102	110	489	44	-	735	694
East Vail	44	-	199	110	-	353	248
Vail Village	102	16	1820	1239	-	3177	1988
West Vail	104	323	1383	78	-	1890	1814
Minturn	315	-	-	174	-	489	322
Dowd-Avon	60	240	512	-	-	812	812
Beaver Creek	-	197	493	790	115	1480	722
Avon	-	119	1128	467	-	1829	1266
Avon-Edwards	-	-	100	440	-	540	118
			1990				
Bighorn	123	133	578	51	-	885	837
East Vail	46	-	208	114	-	368	559
Vail Village	106	17	1898	1291	-	3312	2073
West Vail	125	387	1658	95	-	2265	2174
Minturn	330	-	-	182	-	512	338
Dowd-Avon	81	322	686	-	-	1089	1089
Beaver Creek	-	264	661	1061	-	1986	968
Avon	-	159	1514	626	154	2453	1699
Avon-Edwards	-	-	200	880	-	1080	236

TABLE A-4

AVERAGE DAILY TRAFFIC[1]

Airshed	1975	1980	1985	1990	Miles of Road
			Freeway		
Bighorn	-	9250	10,725	12,200	2.0
East Vail	7167	9250	10,725	12,200	2.5
Vail Village	7167	9250	10,725	12,200	2.5
West Vail	7502	9762	12,022	14,282	2.9
Minturn	-	-	-	-	0.0
Dowd-Avon	4867	7202	9,536	11,871	2.7
Beaver Creek	-	-	-	-	0.0
Avon	4867	7202	9,536	11,871	2.2
Avon-Edwards	4758	6550	8,341	10,132	2.7
			Arterial		
Bighorn	7167	1705	2,214	2,498	2.0
East Vail	1500	1705	1,835	1,780	2.0
Vail Village	4328	4921	5,295	5,136	3.5
West Vail	4328	5700	7,336	8,136	3.0
Minturn	3536	3966	4,396	4,826	2.3
Dowd-Avon	1306	1936	2,566	3,196	2.7
Beaver Creek	-	1084	2,623	3,751	2.0
Avon	1106	3586	6,066	8,546	2.8
Avon-Edwards	640	790	940	1,090	3.3
			Local		
Bighorn	850	1243	1,614	1,821	1.0
East Vail	650	739	795	800	1.0
Vail Village	5000	5685	6,117	6,000	3.0
West Vail	2280	2592	3,336	3,700	2.0
Minturn	1000	1250	1,299	1,300	2.0
Dowd-Avon	280	713	1,725	2,483	2.0
Beaver Creek	-	1141	2,761	3,972	2.0
Avon	645	2836	6,865	9,876	2.0
Avon Edwards	-	-	1,080	2,192	2.0

[1]Traffic for a typical peak day is 1.15 ADT for freeway and arterial traffic. Local peak traffic was obtained from ADT with average/peak population ratios.

SOURCE: Marlatt and Associates, 1976, Colorado Department of Highways and Town of Vail

TABLE A-5

HOURLY TRAFFIC BREAKDOWN

Time	Percentage of Average Daily Traffic
Midnight - 1	1.7
1 - 2	1.0
2 - 3	0.9
3 - 4	0.5
4 - 5	0.5
5 - 6	0.5
6 - 7	1.3
7 - 8	2.6
8 - 9	5.2
9 - 10	6.5
10 - 11	6.0
11 - Noon	6.1
Noon - 1	7.0
1 - 2	7.2
2 - 3	6.8
3 - 4	8.3
4 - 5	9.1
5 - 6	7.4
6 - 7	5.6
7 - 8	4.1
8 - 9	3.2
9 - 10	2.9
10 - 11	2.7
11 - Midnight	1.8

SOURCE: Marlatt and Gelinas, 1975

TABLE A-6

CURRENT AND PROJECTED EMISSION RATES FOR TOTAL SUSPENDED PARTICULATES

Year	Airshed	Total Suspended Particulates: Wood Burning (grams per second)	Total Suspended Particulates: Space Heating (grams per second)	Traffic Average	Trains
1975	Bighorn	8.2	.042	.111	-
	East Vail	4.6	.015	.157	-
	Vail Village	37.3	.470	.381	-
	West Vail	22.5	.075	.294	-
	Minturn	4.7	.032	.071	.079
	Dowd-Avon	1.6	.003	.123	.079
	Beaver Creek	-	-	-	-
	Avon	-	.018	.109	.079
	Avon-Edwards	-	.003	.108	.079
1980	Bighorn	11.4	.057	.168	-
	East Vail	4.9	.015	.197	-
	Vail Village	39.1	.494	.431	-
	West Vail	29.9	.099	.372	-
	Minturn	6.1	.040	.081	.079
	Dowd-Avon	6.1	.009	.189	.079
	Beaver Creek	5.4	-	.034	-
	Avon	9.5	.053	.230	.079
	Avon-Edwards	-	.003	.146	.079
1985	Bighorn	15.1	.072	.199	-
	East Vail	7.3	.016	.226	-
	Vail Village	65.2	.513	.474	-
	West Vail	38.8	.124	.463	-
	Minturn	10.0	.044	.089	.079
	Dowd-Avon	16.7	.026	.262	.079
	Beaver Creek	30.4	-	.081	-
	Avon	37.5	.144	.382	.079
	Avon-Edwards	11.1	.003	.200	.079
1990	Bighorn	18.2	.087	.227	-
	East Vail	7.6	.017	.252	-
	Vail Village	67.9	.534	.501	-
	West Vail	46.5	.150	.536	-
	Minturn	10.5	.046	.096	.079
	Dowd-Avon	22.3	.035	.330	.079
	Beaver Creek	40.7	-	.113	-
	Avon	50.3	.193	.507	.079
	Avon-Edwards	22.2	.006	.253	.079

to obtain a reasonable set of "worst case conditions." Similar conditions are likely to occur once and possibly several times during the winter period in the study area. These assumptions are given in Table A-7 on the following page.

TABLE A-7

METEOROLOGICAL ASSUMPTIONS.

Time	Wind Speed Meters/sec.	(Miles/hr.)	Wind Direction
Midnight - 1	0.6	(1.34)	Downslope
1 - 2	0.6	(1.34)	Downslope
2 - 3	0.6	(1.34)	Downslope
3 - 4	0.6	(1.34)	Downslope
4 - 5	0.6	(1.34)	Downslope
5 - 6	0.6	(1.34)	Downslope
6 - 7	0.6	(1.34)	Downslope
7 - 8	0.6	(1.34)	Downslope
8 - 9	0.6	(1.34)	Downslope
9 - 10	0.6	(1.34)	Downslope
10 - 11	1.2	(2.68)	Upslope
11 - Noon	2.0	(4.47)	Upslope
Noon - 1	2.5	(5.59)	Upslope
1 - 2	2.5	(5.59)	Upslope
2 - 3	2.0	(4.47)	Upslope
3 - 4	1.2	(2.68)	Upslope
4 - 5	0.6	(1.34)	Downslope
5 - 6	0.6	(1.34)	Downslope
6 - 7	0.6	(1.34)	Downslope
7 - 8	0.6	(1.34)	Downslope
8 - 9	0.6	(1.34)	Downslope
9 - 10	0.6	(1.34)	Downslope
10 - 11	0.6	(1.34)	Downslope
11 - Midnight	0.6	(1.34)	Downslope

SOURCE: Vail Meteorological Station data/average adapted for worst case conditions.

APPENDIX D

List, By Community, of Common and Scientific Names of Plant Species Expected To Occur in the Upper Eagle Valley Sanitation District, Eagle County, Colorado.

ASPEN COMMUNITY

Trees	
Aspen	*Populus tremuloides*
Douglas-fir	*Pseudotsuga menziesii*
Engelmann spruce	*Picea engelmannii*
Lodgepole pine	*Pinus contorta*
Shrubs	
Chokecherry	*Prunus virginiana*
Currant	*Ribes* sp.
Serviceberry	*Amelanchier alnifolia*
Wild rose	*Rosa woodsii*
Snowberry	*Symphoricarpos oreophilus*
Herbs	
Arnica	*Arnica cordifolia*
Aster	*Aster engelmannii*
Brome grass	*Bromus carinatus*
Colorado columbine	*Aquilegia caerulea*
Common lupine	*Lupinus argenteus*
Daisy	*Erigeron eximius*
Dandelion	*Taraxacum officinale*
Elk sedge	*Carex geyeri*
Geranium	*Geranium fremontii*
Meadowrue	*Thalictrum fendleri*
Mountain-lover	*Pachystima myrsinites*
Oregon-grape	*Mahonia repens*
Peavine	*Lathyrus leucanthus*
Tall larkspur	*Delphinium occidentale*
Thimble-berry	*Rubus parviflorus*
Thistle	*Cirsium* sp.
Vetch	*Vicia americana*
Wild-rye	*Elymus glaucus*
Wild strawberry	*Fragaria ovalis*
Yarrow	*Achillea lanulosa*
Yellow paintbrush	*Castilleja sulphurea*

MIXED EVERGREEN COMMUNITY

Trees	
Aspen	*Populus tremuloides*
Engelmann spruce	*Picea engelmannii*
Lodgepole pine	*Pinus contorta*
Subalpine fir	*Abies lasiocarpa*

Shrubs

Buffalo-berry	Shepherdia canadensis
Bush honeysuckle	Lonicera involucrata
Kinnikinnick	Arctostaphylos uva-ursi
Serviceberry	Amelanchier alnifolia
Thimble-berry	Rubus parviflorus
Wild rose	Rosa woodsii
Willow	Salix sp.

Herbs

Arnica	Arnica cordifolia
Aster	Aster engelmanni
Bedstraw	Galium triflorum
Dandelion	Taraxacum officinale
Fireweed	Epilobium angustifolium
Hawkweed	Hieracium albiflorum
Lily	Disporum trachycarpum
Lupine	Lupinus argenteus
Meadow rue	Thalictrum fendleri
Mountain-lover	Pachystima myrsinites
Myrtle blueberry	Vaccinium myrtillus
Oregon-grape	Mahonia repens
Peavine	Lathyrus leucanthus
Subalpine daisy	Erigeron eximius
Sweet cicely	Osmorhiza depauperata
Twin flower	Linnaea borealis
Vetch	Vicia americana
Wild Strawberry	Fragaria ovalis
Wintergreen	Pyrola virens

SPRUCE-FIR COMMUNITY

Trees

Aspen	Populus tremuloides
Engelmann spruce	Picea engelmannii
Lodgepole pine	Pinus contorta
Subalpine fir	Abies lasiocarpa

Shrubs

Buffalo-berry	Shepherdia canadensis
Bush honeysuckle	Lonicera involucrata
Currant	Ribes sp.
Thimble-berry	Rubus parviflorus
Willow	Salix sp.

Herbs

Arnica	Arnica cordifolia
Avalanche lily	Erythronium grandiflorum
Bedstraw	Galium triflorum

APPENDIX D (continued)

Herbs (continued)	
Bluegrass	*Poa* sp.
Elk sedge	*Carex geyeri*
Fireweed	*Epilobium angustifolium*
Globeflower	*Trollius laxus*
Lupine	*Lupinus argenteus*
Mountain-lover	*Pachystima myrsinites*
Myrtle blueberry	*Vaccinium myrtillus*
Oregon-grape	*Mahonia repens*
Parry lousewort	*Pedicularis parryi*
Porter lovage	*Ligusticum porteri*
Subalpine daisy	*Erigeron eximius*
Sweet cicely	*Osmorhiza depauperata*
Vetch	*Vicia americana*
Wild strawberry	*Fragaria ovalis*
Wintergreen	*Pyrola virens*

MEADOW COMMUNITY

Shrubs	
Willow	*Salix* sp.

Herbs	
Bluegrass	*Poa agassizensis*
Cow parsnip	*Heracleum lanatum*
Dandelion	*Taraxacum officinale*
False hellebore	*Veratrum tenuipetalum*
Fescue	*Festuca thurberi*
Orchard grass	*Dactylis glomerata*
Plantain	*Plantago lanceolata*
Rush	*Juncus* sp.
Salsify	*Tragopogon pratensis*
Sedge	*Carex* sp.
Sunflower	*Gymnolomia multiflora*
Tarweed	*Madia glomerata*
Thistle	*Cirsium arvense*
Timothy	*Phleum pratense*
Yarrow	*Achillea lanulosa*

MOUNTAIN BRUSH COMMUNITY

Shrubs	
Big sagebrush	*Artemisia tridentata*
Bitterbrush	*Purshia tridentata*
Buffalo-berry	*Shepherdia canadensis*
Chokecherry	*Prunus virginiana*
Mountain mahogany	*Cercocarpus montanus*
Rabbitbrush	*Chrysothamnus nauseosus*

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Shrubs (continued)	
Serviceberry	Amelanchier alnifolia
Snowberry	Symphoricarpos oreophilus
Herbs	
Bluegrass	Poa nemoralis
Indian ricegrass	Oryzopsis hymenoides
Lupine	Lupinus argenteus
Needle-and-thread grass	Stipa comata
Paintbrush	Castilleja flava
Peavine	Lathyrus leucanthus
Scarlet gilia	Ipomopsis aggregata
Sedge	Carex sp.
Showy daisy	Erigeron speciosus
Sulphur-flower	Eriogonum umbellatum
Sunflower	Gymnolomia multiflora
Vetch	Vicia americana
Wheatgrass	Agropyron sp.
Yarrow	Achillea lanulosa

RIPARIAN COMMUNITY

Trees	
Aspen	Populus tremuloides
Colorado blue spruce	Picea pungens
Douglas-fir	Pseudotsuga menziesii
Engelmann spruce	Picea engelmannii
Narrowleaf cottonwood	Populus angustifolia
Rocky Mountain juniper	Juniperus scopulorum
Western red birch	Betula fontinalis
Shrubs	
Alder	Alnus tenuifolia
Chokecherry	Prunus virginiana
Dogwood	Cornus stolonifera
Rocky Mountain maple	Acer glabrum
Willow	Salix sp.
Herbs	
Bedstraw	Galium trifolium
Bittercress	Cardamine cordifolia
Bluebell	Mertensia ciliata
Bluegrass	Poa sp.
Brome	Bromus lanatipes
Clover	Trifolium sp.
Cowbane	Oxypolis fendleri
Cow parsnip	Heracleum lanatum
Dandelion	Taraxacum officinale
False hellebore	Veratrum tenuipetalum

APPENDIX D (continued)

Herbs (continued)	
Fescue	*Festuca thurberi*
Geranium	*Geranium fremontii*
Horsetail	*Equisetum arvense*
Manna grass	*Glyceria striata*
Marsh marigold	*Caltha leptosepela*
Meadowrue	*Thalictrum sparsiflorum*
Monkshood	*Aconitum columbianum*
Northern bedstraw	*Galium boreale*
Orchard grass	*Dactylis glomerata*
Sedge	*Carex* sp.
Swamp wintergreen	*Pyrola asarifolia*
Sweet cicely	*Osmorhiza depauperata*
Timothy	*Phleum pratense*
Three-awn grass	*Agrostis gigantea*
Wild-rye	*Elymus glaucus*
Wild strawberry	*Fragaria ovalis*

Sources: Harrington (1964), Weber (1972)

APPENDIX E

List of Common and Scientific Names of Terrestrial Wildlife Species (Except Birds) Expected to Occur In or Near the Upper Eagle Valley Sanitation District, Eagle County, Colorado.

Common Name	Scientific Name
AMPHIBIANS	
Ambystomids	Ambystomidae
Tiger Salamander	*Ambystoma tigrinum*
True Frogs	Ranidae
Leopard Frog	*Rana pipiens*
REPTILES	
Iguanids	Iguanidae
Sagebrush Lizard	*Sceloporus graciosus*
Eastern Fence Lizard	*Sceloporus undulatus*
Colubrids	Colubridae
Western Terrestrial Garter Snake	*Thamnophis elegans*
Gopher Snake	*Pituophis melanoleucus*
MAMMALS	
Shrews	Soricidae
Vagrant Shrew	*Sorex vagrans*
Vespertilionid Bats	Vespertilionidae
Little Brown Myotis	*Myotis lucifugus*
Long-eared Myotis	*Myotis evotis*
Long-legged Myotis	*Myotis volans*
Townsend's Big-eared Bat	*Plecotus townsendii*
Pikas	Ochotonidae
Pika	*Ochotona princeps*
Hares and Rabbits	Leporidae
Nuttall's Cottontail	*Sylvilagus nuttallii*
Snowshoe Hare	*Lepus americanus*
White-tailed Jack Rabbit	*Lepus townsendii*
Squirrels	Sciuridae
Least Chipmunk	*Eutamias minimus*
Colorado Chipmunk	*Eutamias quadrivittatus*

APPENDIX E(continued)

Common Name	Scientific Name
MAMMALS (Continued)	
Squirrels (Continued)	
Uinta Chipmunk	*Eutamias umbrinus*
Yellow-bellied Marmot	*Marmota flaviventris*
Richardson's Ground Squirrel	*Spermophilus richardsonii*
Golden-mantled Ground Squirrel	*Spermophilus lateralis*
White-tailed Prairie Dog	*Cynomys leucurus*
Red Squirrel	*Tamiasciurus hudsonicus*
Pocket Gopher	Geomyidae
Northern Pocket Gopher	*Thomomys talpoides*
Beavers	Castoridae
Beaver	*Castor canadensis*
New World Rats and Mice	Cricetidae
Deer Mouse	*Peromyscus maniculatus*
Bushy-tailed Woodrat	*Neotoma cinerea*
Montane Vole	*Microtus montanus*
Long-tailed Vole	*Microtus longicaudus*
Southern Red-backed Vole	*Clethrionomys gapperi*
Muskrat	*Ondatra zibethicus*
Jumping Mice	Zapodidae
Western Jumping Mouse	*Zapus princeps*
New World Porcupines	Erethizontidae
Porcupine	*Erethizon dorsatum*
Canids	Canidae
Coyote	*Canis latrans*
Red Fox	*Vulpes vulpes*
Bears	Ursidae
Black Bear	*Ursus americanus*
Procyonids	Procyonidae
Ringtail	*Bassariscus astutus*
Raccoon	*Procyon lotor*
Mustelids	Mustelidae
Marten	*Martes americana*
Ermine	*Mustela erminea*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
Badger	*Taxidea taxus*
Western Spotted Skunk	*Spilogale gracilis*
Striped Skunk	*Mephitis mephitis*

APPENDIX E (continued)

Common Name	Scientific Name
MAMMALS (Continued)	
Cats	Felidae
Mountain Lion	*Felis concolor*
Lynx	*Felis lynx*
Bobcat	*Felis rufus*
Cervids	Cervidae
Wapiti or Elk	*Cervus elaphus*
Mule Deer	*Odocoileus hemionus*

Sources: Armstrong (1972), Colorado Division of Wildlife (1975), Jones et al. (1975), and Stebbins (1966)

APPENDIX F

List of Common and Scientific Names of Birds Expected to Occur In or Near the Upper Eagle Valley Sanitation District, Eagle County, Colorado.

Code*	Common Name	Scientific Name
	Loons	Gaviidae
Mp	Common Loon	Gavia immer
	Grebes	Podicipedidae
Mp	Eared Grebe	Podiceps nigricollis
Mc	Western Grebe	Aechmophorus occidentalis
MSc	Pied-billed Grebe	Podilymbus podiceps
	Cormorants	Phalacrocroracidae
Mp	Double-crested Cormorant	Phalacrocorax auritus
	Herons	Ardeidae
MSc	Great Blue Heron	Ardea herodias
Sp	Little Blue Heron	Florida caerulea
Mp	Snowy Egret	Egretta thula
	Ibises	Threskiornithidae
MSp	White-faced Ibis	Plegadis chihi
	Swans, Geese and Ducks	Anatidae
Mp	Whistling Swan	Olor columbianus
Mc	Canada Goose	Branta canadensis
Mp	Snow Goose	Chen caerulescens
Yc	Mallard	Anas platyrhynchos
Mp	Gadwall	Anas strepera
Mp	Pintail	Anas acuta
Yc	American Green-winged Teal	Anas crecca
Mp	Blue-winged Teal	Anas discors
Mp	Cinnamon Teal	Anas cyanoptera
Mp	American Widgeon	Anas americana
Mc	Shoveler	Anas clypeata
Sc	Wood Duck	Aix sponsa
Mp	Redhead	Aythya americana
Mp	Ring-necked Duck	Aythya collaris
Mp	Canvasback	Aythya valisineria
Mp	Lesser Scaup	Aythya affinis
Wc	Common Goldeneye	Bucephala clangula
Mp	Barrow's Goldeneye	Bucephala islandica
Mp	Bufflehead	Bucephala albeola
Mc	Ruddy Duck	Oxyura jamaicensis
Mp	Hooded Merganser	Lophodytes cucullatus
Yc	Common Merganser	Mergus merganser

APPENDIX F (continued)

Code*	Common Name	Scientific Name
	American Vultures	Cathartidae
Sc	Turkey Vulture	*Cathartes aura*
	Hawks and Harriers	Accipitridae
Yc	Goshawk	*Accipiter gentilis*
Yc	Sharp-shinned Hawk	*Accipiter striatus*
Yc	Cooper's Hawk	*Accipiter cooperii*
Yc	Red-tailed Hawk	*Buteo jamaicensis*
SMc	Swainson's Hawk	*Buteo swainsoni*
Wc	Rough-legged Hawk	*Buteo lagopus*
Sp	Ferruginous Hawk	*Buteo regalis*
Yc	Golden Eagle	*Aquila chrysaetos*
Wc	Bald Eagle	*Haliaeetus leucocephalus*
Yc	Marsh Hawk	*Circus cyaneus*
	Ospreys	Pandionidae
St	Osprey	*Pandion haliaetus*
	Falcons	Falconidae
Mp	Gyrfalcon	*Falco rusticolus*
Yp	Prairie Falcon	*Falco mexicanus*
YSe	Peregrine Falcon	*Falco peregrinus*
Wp	Merlin	*Falco columbarius*
Yc	American Kestrel	*Falco sparverius*
	Grouse	Tetraonidae
Yc	Blue Grouse	*Dendragapus obscurus*
	Turkeys	Meleagrididae
Yp	Wild Turkey	*Meleagris gallopavo*
	Cranes	Gruidae
Mp	Greater Sandhill Crane	*Grus canadensis*
	Rails and Coots	Rallidae
Sp	Sora	*Porzana carolina*
Sc	American Coot	*Fulica americana*
	Plovers	Charadriidae
Yc	Killdeer	*Charadruis vociferus*
	Snipe and Sandpipers	Scolopacidae
Sc	Common Snipe	*Capella gallinago*
Sc	Spotted Sandpiper	*Actitis macularia*
Mp	Solitary Sandpiper	*Tringa solitaria*
Mp	Long-billed Curlew	*Numenius americanus*

APPENDIX F (continued)

Code*	Common Name	Scientific Name
	Snipe and Sandpipers (Cont.)	Scolopacidae
Mp	Lesser Yellowlegs	*Tringa flavipes*
	Avocets	Recurvirostridae
Mp	American Avocet	*Recurvirostra americana*
	Phalaropes	Phalaropodidae
SMc	Wilson's Phalarope	*Steganopus tricolor*
Mp	Northern Phalarope	*Lobipes lobatus*
	Gulls and Terns	Laridae
Su	California Gull	*Larus californicus*
Mu	Ring-billed Gull	*Larus delawarensis*
Mp	Franklin's Gull	*Larus pipixcan*
Sp	Forster's Tern	*Sterna forsteri*
	Pigeons and Doves	Columbidae
SMc	Band-tailed Pigeon	*Columba fasciata*
Yc	Rock Dove	*Columba livia*
Sc	Mourning Dove	*Zenaida macroura*
	Typical Owls	Strigidae
Yc	Great Horned Owl	*Bubo virginianus*
Yp	Pygmy Owl	*Glaucidium gnoma*
Sp	Burrowing Owl	*Athene cunicularia*
Uu	Long-eared Owl	*Asio otus*
Uu	Saw-whet Owl	*Aegolius acadicus*
	Nighthawks	Caprimulgidae
Sc	Common Nighthawk	*Chordeiles minor*
	Swifts	Apodidae
Sp	Black Swift	*Cypseloides niger*
Sc	White-throated Swift	*Aeronautes saxatalis*
	Hummingbirds	Trochilidae
Sc	Black-chinned Hummingbird	*Archilochus alexandri*
Sc	Broad-tailed Hummingbird	*Selasphorus platycercus*
Mc	Rufous Hummingbird	*Selasphorus rufus*
	Kingfishers	Alcedinidae
Yc	Belted Kingfisher	*Megaceryle alcyon*
	Woodpeckers	Picidae
Yc	Common Flicker	*Colaptes auratus*
Yp	Red-headed Woodpecker	*Melanerpes erythrocephalus*

APPENDIX F (continued)

Code*	Common Name	Scientific Name
	Woodpeckers (Cont.)	Picidae
Mu	Lewis' Woodpecker	Asyndesmus lewis
Sc	Yellow-bellied Sapsucker	Sphyrapicus varius
Su	Williamson's Sapsucker	Sphyrapicus thyroideus
Yc	Hairy Woodpecker	Picoides villosus
Yc	Downy Woodpecker	Picoides pubescens
Yc	Northern Three-toed Woodpecker	Picoides tridactylus
	Flycatchers	Tyrannidae
Sp	Eastern Kingbird	Tyrannus tyrannus
SMc	Western Kingbird	Tyrannus verticalis
Sc	Say's Phoebe	Sayornis saya
SMc	Western Flycatcher	Empidonax difficilis
SMc	Hammond's Flycatcher	Empidonax hammondii
SMu	Dusky Flycatcher	Empidonax oberholseri
Sp	Gray Flycatcher	Empidonax wrightii
Sc	Western Wood Pewee	Contopus sordidulus
Sc	Olive-sided Flycatcher	Nuttallornis borealis
	Larks	Alaudidae
Yc	Horned Lark	Eremophila alpestris
	Swallows	Hirundinidae
Sc	Violet-green Swallow	Tachycineta thalassina
Sc	Tree Swallow	Iridoprocne bicolor
Sc	Rough-winged Swallow	Stelgidopteryx ruficollis
Sc	Barn Swallow	Hirundo rustica
Sc	Cliff Swallow	Petrochelidon pyrrhonota
	Jays and Crows	Corvidae
Mp	Blue Jay	Cyanocitta cristata
Yc	Steller's Jay	Cyanocitta stelleri
Yc	Scrub Jay	Aphelocoma coerulescens
Yc	Black-billed Magpie	Pica pica
Yc	Common Raven	Corvus corax
Yc	Pinyon Jay	Gymnorhinus cyanocephalus
Yc	Clark's Nutcracker	Nucifraga columbiana
	Chickadees and Titmice	Paridae
Yc	Black-capped Chickadee	Parus bicolor
Yc	Mountain Chickadee	Parus gambeli
Yc	Plain Titmouse	Parus inornatus
	Nuthatches	Sittidae
Yc	White-breasted Nuthatch	Sitta carolinensis
Yp	Red-breasted Nuthatch	Sitta canadensis

APPENDIX F (continued)

Code*	Common Name	Scientific Name
	Creepers	Certhiidae
Yc	Brown Creeper	*Certhia familiaris*
	Dippers	Cinclidae
Yc	Dipper	*Cinclus mexicanus*
	Wrens	Troglodytidae
Sp	House Wren	*Troglodytes aedon*
Sc	Canyon Wren	*Salpinctes mexicanus*
Sc	Rock Wren	*Salpinctes obsoletus*
	Mimics	Mimidae
Mp	Mockingbird	*Mimus polyglottos*
SMp	Catbird	*Dumetella carolinensis*
Sc	Sage Thrasher	*Oreoscoptes montanus*
	Thrushes and Bluebirds	Turdidae
Yc	Robin	*Turdus migratorius*
Sc	Hermit Thrush	*Catharus guttata*
Sc	Swainson's Thrush	*Catharus ustulata*
Sp	Veery	*Catharus fuscescens*
Uc	Western Bluebird	*Sialia mexicana*
Sc	Mountain Bluebird	*Sialia currucoides*
Yc	Townsend's Solitaire	*Myadestes townsendi*
	Gnatcatchers and Kinglets	Sylviidae
Mp	Blue-gray Gnatcatcher	*Polioptila caerulea*
Sc	Golden-crowned Kinglet	*Regulus satrapa*
SMc	Ruby-crowned Kinglet	*Regulus calendula*
	Pipits	Motacillidae
Sc	Water Pipit	*Anthus spinoletta*
	Waxwings	Bombycillidae
Mp	Bohemian Waxwing	*Bombycilla garrulus*
Wc	Cedar Waxwing	*Bombycilla cedrorum*
	Shrikes	Laniidae
Wc	Northern Shrike	*Lanius excubitor*
Yc	Loggerhead Shrike	*Lanius ludovicianus*
	Starlings	Sturnidae
Yc	Starling	*Sturnus vulgaris*
	Vireos	Vireonidae
Sc	Gray Vireo	*Vireo vicinior*
Sc	Solitary Vireo	*Vireo solitarius*
Sc	Warbling Vireo	*Vireo gilvus*

APPENDIX F (continued)

Code*	Common Name	Scientific Name
	Warblers	Parulidae
Sc	Orange-crowned Warbler	*Vermivora celata*
Sp	Nashville Warbler	*Vermivora ruficapilla*
Mp	Virginia's Warbler	*Vermivora virginiae*
Sc	Yellow Warbler	*Dendroica petechia*
SMp	Black-throated Blue Warbler	*Dendroica caerulescens*
SMc	Yellow-rumped Warbler	*Dendroica coronata*
Mp	Townsend's Warbler	*Dendroica townsendi*
Mp	Chestnut-sided Warbler	*Dendroica pensylvanica*
Sp	MacGillivray's Warbler	*Oporornis tolmiei*
Mu	Yellowthroat	*Geothlypis trichas*
SMc	Wilson's Warbler	*Wilsonia pusilla*
	Weaver Finches	Ploceidae
Yc	House Sparrow	*Passer domesticus*
	Meadowlarks, Blackbirds and Orioles	Icteridae
Sp	Bobolink	*Dolichonyx oryzivorus*
Sc	Western Meadowlark	*Sturnella neglecta*
SMc	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Yc	Red-winged Blackbird	*Agelaius phoeniceus*
Sc	Northern Oriole	*Icterus galbula*
Wc	Rusty Blackbird	*Euphagus carolinus*
Yc	Brewer's Blackbird	*Euphagus cyanocephalus*
Yc	Common Grackle	*Quiscalus quiscula*
Yc	Brown-headed Cowbird	*Molothrus ater*
	Tanagers	Thraupidae
SMc	Western Tanager	*Piranga ludoviciana*
	Grosbeaks, Finches, Sparrows and Buntings	Fringillidae
SMp	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Sc	Black-headed Grosbeak	*Pheucticus melanocephalus*
SMp	Lazuli Bunting	*Passerina amoena*
Yc	Evening Grosbeak	*Hesperiphona vespertina*
WMp	Purple Finch	*Carpodacus purpureus*
Yc	Cassin's Finch	*Carpodacus cassinii*
Yc	House Finch	*Carpodacus mexicanus*
Yc	Pine Grosbeak	*Pinicola enucleator*
Wc	Gray-crowned Rosy Finch	*Leucosticte tephrocotis*
Wc	Black Rosy Finch	*Leucosticte atrata*
Yc	Brown-capped Rosy Finch	*Leucosticte australis*
Wc	Common Redpoll	*Carduelis flammea*
Yc	Pine Siskin	*Carduelis pinus*

APPENDIX F(continued)

Code*	Common Name	Scientific Name
	Grosbeaks, Finches, Sparrows and Buntings	Fringillidae
SMp	American Goldfinch	Carduelia tristis
SMc	Lesser Goldfinch	Carduelia psaltria
Sc	White-winged Crossbill	Loxia leucoptera
SMc	Green-tailed Towhee	Pipilo chlorura
Sc	Rufous-sided Towhee	Pipilo erythrophthalmus
Mp	Lark Bunting	Calamospiza melanocorys
Sc	Savannah Sparrow	Passerculus sandwichensis
Mp	Vesper Sparrow	Pooecetes gramineus
SMc	Lark Sparrow	Chondestes grammacus
WMc	Dark-eyed Junco	Junco hyemalis
Yc	Gray-headed Junco	Junco caniceps
Wc	Tree Sparrow	Spizella arborea
Sc	Chipping Sparrow	Spizella passerina
Mp	Brewer's Sparrow	Spizella breweri
Wp	Harris' Sparrow	Zonotrichia querula
SMc	White-crowned Sparrow	Zonotrichia leucophrys
Yc	Song Sparrow	Melospiza melodia
Sc	Lincoln's Sparrow	Melospiza lincolnii
Mp	Swamp Sparrow	Melospiza georgiana

* Y = Year-round resident
M = Migrant, only seen during migratory periods
S = Summer resident
W = Winter resident
U = Unknown

e = Endangered. A wildlife population is endangered when its prospects for survival and reproduction within an area are in jeopardy or are likely to become so within the foreseeable future. Any substantial reduction or displacement of a wildlife population resulting from a change in land use could cause an otherwise normal population to become endangered in status.

t = Threatened. A wildlife population is rated threatened when the individuals constituting the population exist in such small numbers or are so restricted in their general distribution that they may become endangered.

c = Common. A population is considered common when its level is compatible with the existing habitat and is currently secure because its essential habitat is not threatened by environmental degradation.

p = Peripheral. A peripheral population is one which, because of being on the perimeter of its normal geographical range, occurs in low

numbers. Although not endangered or threatened in its population distribution as a whole, peripheral populations are subject to becoming endangered by relatively minor changes in their habitats. Such populations are seldom of substantial state interest unless habitat enhancement measures will result in their status being upgraded.

u = Undetermined or unknown.

Sources: American Ornithologist's Union (1957, 1973), Bailey and Niedrach (1965), Colorado Division of Wildlife (1975), and

APPENDIX G

Macro-Invertebrate Abundance, Upper Eagle River Valley, Colorado.[1]

Station Number-River Mileage	Station Description
57.7-0.5	Eastfork of Eagle River 0.5 Mile Upstream of Confluence
57.7-10	West Fork of Eagle River 1 Mile Upstream from Confluence
50	Eagle River 0.5 Mile Upstream of Redcliff, Colorado
49.9-0.1	Turkey Cr. One-tenth Mile Upstream of Confluence with Eagle
49.5	Eagle River 0.2 Mile Upstream of the Confluence with Homestake Cr.
49.3-1.0	Homestake Creek One Mile Upstream from Confluence with Eagle River
48	Eagle River 0.5 Mile Upstream from Belden
47.5	Eagle River at Gelman Upstream of Tailings Piles
46.5 lf	Eagle River (left bank) at Discharge of Old New Jersey Tailings Ponds. Not Influenced by Discharge.
46.5 rt	Eagle River (right bank) at Discharge of Old New Jersey Tailings Ponds. Influenced by Discharge.
44.2	Eagle River Upstream from Spring Effluent of New Jersey Zinc Tailings Ponds
43.8-0.2	Cross Creek 0.2 Mile Upstream from Eagle River
43.8-4.0	Cross Creek 0.5 Mile Upstream from New Jersey Zinc Tailings Ponds Effluents
42.5	Eagle River One Mile Upstream of Minturn, Colorado
40.1	Eagle River 1.5 Mile Downstream of Minturn, Colorado, One Mile Upstream of Gore Creek Confluence

APPENDIX G (continued)

Station Number-River Mileage	Station Description
39.9-4	Gore Creek One Mile Upstream of Vail, Colorado
39.9-1.0	Gore Creek One Mile Upstream of Confluence with Eagle River
13.1	Eagle River 0.5 Mile Upstream of Eagle, Colorado
11.9	Eagle River One Mile Downstream of Eagle, Colorado
6.8	Eagle River 1.0 Mile Downstream of Gypsum, Colorado
0.2	Eagle River 0.2 Mile Upstream from the Confluence with the Colorado
46.5-0.1	Effluent from Old New Jersey Zinc Ponds
44.1-0.2	Spring Drain from New New Jersey Zinc Ponds
43.8-3.0-0.1	Effluent from New New Jersey Zinc Ponds to Cross Creek

APPENDIX G (continued)

	39.9-4	39.9-1.0	13.1	11.9	6.8	0.2	46.5-0.1	44.1-0.2	43.8-3.0-0.1
Stoneflies									
Pteronarcys sp.	--	--	--	--	1	--			
Pteronarcella sp.	--	9	7	96	2	--			
Brachyptera sp.	4	5	3	--	1	3			
Isoperla sp.	--	7	--	32	--	--			
Mayflies									
Heptagenia sp.	1	1	3	--	4	6			
Rhithrogena sp.	14	2	4	--	1	8			
Ephemerella sp.	26	25	--	8	4	--			
Baetis sp.	2	1	--	--	--	--			
Pacudocloeon sp.	--	--	--	--	--	2			
Caddis flies									
Heliopsyche sp.	--	--	--	--	6	1			
Glossosoma sp.	--	79	29	24	129	--			
Brachycentrus sp.	20	185	141	256	243	26			
Hydropayche sp.	--	--	13	128	31	170			
Cheumatopsyche sp.	--	--	--	--	7	162			
Arctopsyche sp.	4	37	3	--	--	--			
Agraylea sp.	--	--	--	--	--	5			
Psychomyia sp.	--	2	--	--	--	--			
Beetles									
Heterlimnium sp.	--	3	5	640	10	--			
Optioservus sp.	--	--	--	560	9	--			
Blackflies									
Prosimulium sp.	--	--	--	--	--	1			
Midges									
Microtendipes sp.	--	--	--	--	4	--			
Spaniotoma sp.	4	10	1	88	--	3			
Cricotopus sp.	--	3	--	--	--	--			
Tipulidae	--	11	2	1	--	1			
Atherix sp.	--	--	3	2	1	2			
Blepharoceridae	--	4	--	--	--	--			
Sludgeworms	--	2	--	--	--	--			
No. of Kinds	8	17	12	11	15	13			
Number Per Sq. Ft.	75	385	214	1835	453	390			
CHEMICAL DATA - mg/l									
Total Iron	<0.2	<0.2	0.2	0.3	0.3	0.5	2700	60.0	1.1
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.02
Manganese	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	880	310	14.0
Zinc	<0.02	<0.02	0.04	0.03	0.04	0.03	240	26.0	6.0
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	1.1	0.13	0.06
Molybdenum	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	--

APPENDIX G (continued)

1217.4-0.2	57.7-0.5	57.7-1.0	50	49.9-0.1	49.5	49.3-1.0	48	47.5	46.5 (Lf)	46.5 (Rt)	44.2	43.8-0.2	43.8-4.0	42.5	40.1
Stoneflies															
Brachyptera sp.	8	1	7	20	8	17	2	11	--	--	--	--	4	4	7
Isoperla sp.	--	3	--	24	7	12	1	--	4	--	--	--	2	4	4
Pteronarcella sp.	--	--	1	--	3	16	--	15	4	--	2	--	--	--	11
Nemoura sp.	--	--	--	8	1	2	--	--	--	--	--	--	6	--	--
Mayflies															
Ephemerella sp.	60	10	33	50	141	114	22	11	16	--	--	1	44	--	6
Heptagenia sp.	8	3	1	5	--	2	--	--	--	--	--	--	12	--	--
Baetis sp.	--	7	26	45	11	--	2	--	--	--	--	--	2	--	1
Pseudocloeon sp.	--	--	6	37	2	--	2	--	--	--	--	--	2	--	--
Rhithrogena sp.	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--
Paraleptophlebia sp.	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--
Caddis flies															
Psychomyia sp.	4	1	--	--	20	--	1	--	--	--	--	--	--	--	--
Arctopsyche sp.	4	3	100	3	9	37	15	3	3		1	2	6	22	12
Brachycentrus sp.	12	--	21	88	11	17	4	3	14		--	--	14	--	1
Polycentropus sp.	4	--	--	--	--	--	--	--	--		--	--	--	--	--
Glossosoma sp.	--	--	10	--	72	1	--	--	2		--	3	38	--	1
Hydropsyche sp.	--	--	--	--	--	--	--	--	--		--	--	--	--	--
Beetles															
Heterlimnius sp.	12	18	26	8	19	1	1	--	4		--	3	--	--	6
Optioservus sp.	--	5	--	4	--	--	--	--	--		--	2	--	--	--
Cylloepus sp.	--	--	--	--	--	--	--	--	--	NONE	--	--	--	--	2
Midges															
Spaniotoma sp.	4	6	2	19	56	5	80	30	4		--	--	--	4	80
Pseudochironomus sp.	--	4	--	--	--	--	--	--	--		--	--	18	--	--
Pentaneura sp.	--	--	6	--	5	2	--	--	2		--	1	--	--	--
Cricotopus sp.	--	--	--	--	--	--	28	--	2		--	--	--	--	16
Atherix sp.	--	--	--	--	--	--	--	1	--		--	Algae	--	--	--
Tipulidae	--	--	--	8	17	--	5	1	--		--		2	--	5
Biting Midges															
Palpomyia sp.	8	--	--	--	--	2	--	--	--	--	--	--	--	--	--
Psychodidae	8	--	1	1	1	--	--	--	--	--	--	--	--	--	--
Empididae	--	1	1	2	2	--	--	--	2	--	--	2	--	--	--
Planarians	--	--	--	--	1	--	5	--	--	--	--	--	--	--	--
Nematodes	--	2	--	1	1	--	4	--	--	--	--	--	--	--	1
Sludgeworms	--	2	--	--	--	36	30	2	4	--	--	--	6	--	--
Number of Kinds	11	14	14	16	19	14	15	9	13	0	2	8	14	4	14
Number Per Sq. Ft.	132	66	241	323	387	264	202	77	70	0	3	15	158	34	153
CHEMICAL DATA - mg/l															
Total Iron	<0.2	0.6	0.2		<0.2	0.5	0.5	0.4	4.3	38.4	1.6	1.0	0.2	1.4	0.9
Chromium	<0.02	<0.02	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	<0.1	<0.1	<0.1		<0.1	<0.1	0.1	<0.1	0.2	10.6	1.1	4.3	<0.1	2.0	1.6
Zinc	<0.02	<0.02	<0.02		<0.02	<0.02	0.13	0.02	0.15	4.1	0.31	1.7	<0.02	0.58	0.57
Copper	<0.02	<0.02	0.02		<0.02	<0.02	<0.02	<0.02	<0.02	0.10	<0.02	<0.02	<0.02	<0.02	<0.02
Molybdenum	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	0.02	0.01	<0.01		0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	<0.01	0.01

APPENDIX H

AQUATIC ANIMAL SPECIES KNOWN TO OCCUR IN EAGLE COUNTY, COLORADO[1]

Common Name	Population Status
Fish	
Kokanee Salmon	c
Mountain Whitefish[3]	p
Cutthroat Trout[3]	c
Rainbow Trout[3]	c
Brown Trout[3]	c
Brook Trout[3]	c
Lake Trout[3]	c
Arctic Grayling	p
Goldfish	u
Bonytail	e
Roundtail Chub	c
Colorado Squawfish	e
Speckled Dace[3]	c
Longnose Sucker[3]	c
Crustaceans	
Fairy Shrimp[3]	u
Water Fleas[3]	c
Fish Lice[3]	c
Opossium Shrimp[3]	u
Aquatic Sow Bugs	c
Scuds[3]	c

1 Species listed are all year-round residents of Eagle County.
2 c = common; e = endangered; u = undetermined or unknown; p = peripherial (occurrence within the county is on the perimeter of the animals normal geographical range -- it therefore occurs in low numbers).
3 Species which are found within the study area.

SOURCE: Based on the Colorado Division of Wildlife's Master Check List of Colorado Wildlife for Eagle County, 1975.

APPENDIX I

Explanation of Bedrock Geology Units

Qal
Alluvium

PHYSICAL DESCRIPTION: Alluvium of streams tributary to Eagle, Colorado and Fryingpan Rivers. Composition depends on source. Generally consists of fine-grained sandy silts and silty clays with minor gravel. Generally less than 20 feet thick. May show bedding in part but changes abruptly laterally. Deposit generally thick in the middle and thin on the edges.

TOPOGRAPHIC EXPRESSION: Generally flat with a thin vegetative cover. The area is subject to recurrent erosion and deposition.

WEATHERING CHARACTERISTICS: Composed of transported colluvium or material weathered from bedrock. Not appreciably affected by additional weathering.

WORKABILITY: Excavation easy with backhoe or other power equipment, may have locally high water table. Compaction moderately easy, rollers and vibratory compactors suggested. If organic material constitutes more than 10 percent by volume, the material should not be used in compacted fill, as it may rebound when wet. Drilling easy.

DRAINAGE AND ERODIBILITY: Infiltration rapid in sandy areas, slow in clayey areas. Runoff rapid when water table is at the surface. Moderately rapid during period of high rainfall. Easily erodible by both gully wash and stream scour.

GROUND WATER CHARACTERISTICS: Permeability moderate. Water table at or near the surface. Well yield not developed, normally high during water flow in stream but is tributary. Quality generally highly mineralized, good for stock use.

WASTE DISPOSAL: Very poor for septic systems and dump sites due to ground water pollution hazard.

FOUNDATION STABILITY: Generally good but high ground water table common.

SLOPE STABILITY: Generally stable, may have high ground water table.

RELATED GEOLOGIC HAZARDS: Within physiographic flood plain may be susceptible to recurrent flooding.

KNOWN AND POSSIBLE RESOURCES: Generally suitable for most construction and non-construction purposes such as layering in land fill, road fill, etc.

Qm
Glacial Moraine

PHYSICAL DESCRIPTION: Boulders, gravel, sand and silt deposited by glaciers. Generally less than 100 feet in thickness, but may reach 200-300 feet thickness. Consists primarily of Precambrian granites and gneisses.

TOPOGRAPHIC EXPRESSION: Low hummocky topography, generally vegetated with local high water table.

WEATHERING CHARACTERISTICS: Little soil, mainly forest mat over the hummocky topography. Rocks in the moraine may be decomposed.

WORKABILITY: Excavation difficult to easy, large boulders may be encountered locally. Backhoe can be used in some areas. Compaction moderately easy, vibratory compactors and smooth tired rollers commonly used, easy where large boulders are absent or removed before emplacement. Drilling easy to difficult, depending on numbers of cobbles and boulders present.

DRAINAGE AND ERODIBILITY: Infiltration generally moderate to rapid, may be local ponding in clay enriched areas. Runoff moderately slow on slopes. Erodibility slight by sheet and gully wash, moderate to high by stream scour.

GROUND WATER CHARACTERISTICS: Permeability high. Water table at or near land surface. Well yield not developed, may be good supply but is seasonal. Quality varies but is generally good with domestic and stock use.

WASTE DISPOSAL: Septic Systems, satisfactory to unsatisfactory depending on percolation rates and ground water levels. Dump sites, poor because excavation may be difficult and hazard of ground water pollution is high.

FOUNDATION STABILITY: Generally good below frost heave zone.

SLOPE STABILITY: Moderate, material is generally unconsolidated and may slide if it becomes water saturated on moderate to steep slopes. Vertical cuts may stand for several months but will ravel and slump on wetting and drying over several seasons. Angle of repose about 35°.

REALTED GEOLOGIC HAZARDS: May have potentially unstable slopes in steeper areas and in water saturated areas.

KNOWN AND POSSIBLE RESOURCES: Possible local source of fair quality aggregate. May locally be good for filter drain.

Ti
Tertiary Intrusives

PHYSICAL DESCRIPTION: Regionally the tertiary intrusives range from porphiritic to basaltic dikes and sills. Many of the sills are less than five feet thick. The only tertiary intrusive within the study area is a latite porphyry sill which follows the right bank of the Eagle River at Red Cliff. The sill reaches a maximum thickness of 150 feet a mile southeast of Red Cliff, then thins to the northwest and feathers out just south of Two Elk Creek. This sill is the caprock for the zinc-bearing Gilman ore body in the Leadville Limestone.

TOPOGRAPHIC EXPRESSION: Narrow Tertiary intrusive sills run parallel to bedding planes in much of the stratigraphic sequence. The sill near Red Cliff intrudes between the Leadville Limestone of Mississippian age and the Pennsylvanian Maroon Formation.

WEATHERING CHARACTERISTICS: Generally resistant except for narrow sills in sedimentary section. Intermittent streams on flow surfaces may show some joint control. At edges of volcanic flows coarse talus tends to accumulate. Forms prominent ridge south of Red Cliff.

WORKABILITY: Excavation difficult to very difficult, with degree of jointing the critical factor. Blasting would probably be necessary over much of the area. Compaction difficult and generally requires crushing and mixing with binder material. Steel wheeled and rubber-tired rollers suggested. Drilling moderate to difficult.

DRAINAGE AND ERODIBILITY: Infiltration into rock negligible. Moderate to slow through fractures. Runoff rapid to moderate. Erodibility very resistant for igneous rocks such as the porphyry near Red Cliff. Some ash flows and tuffaceous Tertiary volcanics easily eroded.

GROUND WATER CHARACTERISTICS: Permeability generally poor, with joint and fracture density the critical factor. Water table unknown, may be essentially nonexistent due to porosity and thickness of sills in most places. May be present locally in open but discontinuous fractures and in shallow depressions not buried by flows. Well yield undeveloped, probably undependable. Yields water in small amounts as generally temporary springs at base of unit, notable after snow melt or heavy rain. Water quality unknown, probably good with moderate mineralization. Has been developed and used as minor source for stock use in some areas.

WASTE DISPOSAL: Septic systems unsatisfactory due chiefly to lack of material for burial. Pollution of local ground water by leakage through fracture systems is a possibility. Dump sites unsuitable, chiefly because excavation of sanitary cover is difficult. Great risk of ground water pollution through fracture systems.

FOUNDATION STABILITY: Excellent. May be some danger of rockfall and unstable slopes at margins of excavations. In other areas of the county ash falls have poor stability for foundations and are subject to swelling.

SLOPE STABILITY: Mostly excellent, but poor to fair within twenty-five feet of margins due to rockfall. Very poor in ash falls of other areas.

RELATED GEOLOGIC HAZARDS: Rockfall hazard should in general be considered high near margins of the sills. Talus slopes are developed along many of the margins overlying potentially unstable materials. Large blocks along margins may fall as an occasional occurence. Small landslides common on ash flows and tuffaceous sedimentary rocks in other regions of Eagle County.

KNOWN AND POSSIBLE RESOURCES: Possible source of riprap, crushed aggregate and road aggregate.

IPPm

Maroon Formation

PHYSICAL DESCRIPTION: Approximately 1,000 to 4,000 feet of red mudstones, shale, siltstone and fine-grained sandstone. Unit is designed as all rocks above the Jacque Mountain Limestone and below the Weber Sandstone or the Chinle, whichever is present. The following sample date were taken from deep drill holes and can be considered average data for unweathered bedrock: moisture content, 1.05-5.05%; density, 141-164 pcf; shear strengths, 231-6254 psi; modulus of elasticity, 6.3-102 x 10^4 psi.

TOPOGRAPHIC EXPRESSION: South facing scarp slopes generally grassy or shrub covered. North facing scarp slopes generally wooded. Scarp slopes gentle to greater than 40°. Bedding is generally seen as light and dark colored bands on grassy slopes.

WEATHERING CHARACTERISTICS: Weathers to fine red silty clay.

WORKABILITY: Excavation easy to moderate in weathered zone, becoming more difficult with depth. Tractor drawn scrapers and rippers suggested. Compaction generally good, but sandstones may have to be combined with binder before compaction with smooth tired rollers. Drilling moderate to difficult.

DRAINAGE AND ERODIBILITY: Infiltration generally negligible in shales, negligible to low in siltstones and sandstones, moderate along fractures and joints. Runoff, moderate. Fairly resistant to stream scour and moderately resistant to gully and slope wash.

GROUND WATER CHARACTERISTICS: Permeability generally negligible to low, low in weathered zone. Water table unknown, probably varies greatly. Well yield not developed, probably poor to fair depending upon location, with siltstones and sandstones giving best yield. Quality probably highly mineralized with possible stock use.

WASTE DISPOSAL: Septic systems generally unsatisfactory, shales too impermeable with possibility of ground water pollution in siltstones. Dump sites generally fair to poor, difficult to excavate in many areas with associated hazard of ground water pollution.

FOUNDATION STABILITY: Good. Blocks may slide on bedding planes into excavations. Shales may be expansive in part.

SLOPE STABILITY: Dipslopes on shale may tend to slide. Bedding that dips into cuts may slide on the dipslopes. Steep slopes initiated by construction may alter drainage and initiate slides in the weathered zone.

RELATED GEOLOGIC HAZARDS: Potentially unstable slopes and snow avalanche hazard at higher elevations and in steep valleys are primary hazards. Dipslope sliding of weathered bedrock is also possible.

KNOWN AND POSSIBLE RESOURCES: Generally suitable for most construction and non-construction purposes, road fill, layering in land fills, etc.

Pe
Eagle Valley Formation
Peg
Bedded Evaporites

PHYSICAL DESCRIPTION: Evaporite interval consists of lense shaped deposit about 3,000 feet thick with deepest portion near the center of the county. Interfingers with the Minturn Formation on the east and Morgan Formation on the west. At type locality is mainly light colored gypsiferous mudstone and siltstone containing some bedded gypsum, a few cherty dark gray limestone beds about one foot thick, a few beds of reddish shale and siltstone. In some areas the gypsum is massively bedded, displays chaotic internal structure in bluffs. Halite locally common.

TOPOGRAPHIC EXPRESSION: Irregular topography with bluffs and sinkholes. Landslide topography in areas of steep slopes.

WEATHERING CHARACTERISTICS: Weathers very rapidly and is water soluble. Forms large solution cavities in some areas. Slopes generally unstable in bedded deposits.

WORKABILITY: Excavation very easy. Compaction generally easy. Poorly consolidated, not recommended for road beds or foundations.

DRAINAGE AND ERODIBILITY: High infiltration in many areas, moderate in gypsiferous mudstones and shales. Runoff moderate. Easily erodible by stream, gully and slope wash. Poorly cemented by water soluble materials.

GROUND WATER CHARACTERISTICS: Permeability generally high, moderate in impure rock materials such as gypsiferous mudstones. Water table unknown. Well yield unknown, probably unreliable. Quality highly mineralized, highly corrosive, potassium salts identified in some drill holes, no known use.

WASTE DISPOSAL: Septic systems unsatisfactory because of high permeability and ground water pollution hazard. Dump sites very poor because of high permeability and hazard of ground water pollution.

FOUNDATION STABILITY: Fair, control of surface and sub-surface drainage is critical.

SLOPE STABILITY: Subsidence of the surface due to solution. Landslides and general instability of the slopes are the major geological hazards.

RELATED GEOLOGIC HAZARDS: Relatively unstable slopes, numerous landslides because of infiltration and solubility of bedrock. Sink holes and solution caverns.

KNOWN AND POSSIBLE RESOURCES: Gypsum and other evaporites may be economically feasible under part of the Eagle River Valley in the future. Various agricultural purposes.

IPm
Minturn Formation

PHYSICAL DESCRIPTION: About 6,000 feet of interbedded medium to very coarse grained gray to reddish-brown sandstone, conglomeratic sandstone, thin beds of reddish-brown siltstone and sandy to silty shale with distinctive interbedded pink to gray limestones and dolomites. Overlies the Belden or on Precambrian rocks and is below the Maroon. Interfingers with the Eagle Valley Formation west of Dowds Junction. Testing of unweathered sandstones and conglomerates within the Minutrn yield: moisture content, 0.1-10.9%; unit weight, 130.9 pcf-166.5 pcf; modulus of elasticity, 1.0-12 x 10^5 psi. Shales may be expected to have different values.

TOPOGRAPHIC EXPRESSION: Generally forms steep slopes with limestones making prominent steps on the slopes. Forms both grassy and tree covered slopes.

WEATHERING CHARACTERISTICS: Weathers to a red silty clay staining the gray limestone steps a pinkish color.

WORKABILITY: Excavation easy to moderate in weathered zone, becoming more difficult with depth. Blasting may be required for deep excavations. Compaction generally good, but coarser sandstones and limestones must be mixed with binder before compaction. Drilling moderate to difficult.

DRAINAGE AND ERODIBILITY: Infiltration generally negligible in shales and negligible to low in siltstones, sandstones, limestones, conglomerates. Moderate along fractures and joints. Runoff moderate to high. Erodibility, fair resistance to stream scour and moderate resistance to gully and slope wash.

GROUND WATER CHARACTERISTICS: Permeability generally negligible to low, low in weathered zone, moderate in fractured areas. Water table unknown, probably varies. Well yield undeveloped, probably poor in shales to fair in siltstones, sandstones, conglomerates and limestones. Water probably mineralized, probably used for stock and some domestic.

WASTE DISPOSAL: Poor for septic systems, hazard of ground water pollution in sandstones and siltstones may be moderate. Dump sites, generally unsatisfactory, excavation difficult and hazard to ground water source.

FOUNDATION STABILITY: Generally good.

SLOPE STABILITY: Dipslopes on shale may tend to slide. Bedding that dips into cuts may slide on bedding planes. In many areas as steep slopes are developed, construction may alter drainage in the weathered zone and may initiate slides.

RELATED GEOLOGIC HAZARDS: Potentially unstable slopes and snow avalanches at higher elevations in the steep valleys are primary hazards involved. Some landsliding in weathered zone and on bedding surfaces may occur.

KNOWN AND POSSIBLE RESOURCES: Generally suitable for construction and non-construction purposes. Limestones may provide local source of aggregate. Has been prospected for uranium in the Vail area.

IPb
Belden Formation

PHYSICAL DESCRIPTION: Alternating beds of dark gray or black fine grained fossiliferous limestones and gray to black fissile shale. Two massive, arkosic conglomeratic sandstone units occur near the middle of the formation and a few beds of micaceous siltstone occur near the top of the unit. Thickness ranges from 700 to 125 feet, with generally two-thirds of the formation comprised of shale. Beds are discontinuous and lie on a karst surface at the top of the Leadville Limestone. The cave fillings and red regolith on top of the Leadville is termed the Molas Formation and is included with the Belden Formation for simplicity. Sandstone porosity is 10 to 15%. Shales are expansive in part.

TOPOGRAPHIC EXPRESSION: Generally occurs in valleys and is poorly exposed. Limestones and sandstones form resistant ridges on the slopes.

WEATHERING CHARACTERISTICS: Weathers to a gray to buff silt with small pieces of limestone, sandstone and shale.

WORKABILITY: Excavation easy to difficult with most power equipment. Thin limestones and shales are ripable. Thicker sandstones and limestones may require blasting. Compaction easy in shales, limestones and sandstones should be removed, crushed and mixed with binder before emplacement. Sheepsfoot and smooth tired rollers suggested. Drilling moderate to difficult.

DRAINAGE AND ERODIBILITY: Infiltration negligible in shales, moderately high in sandstones and less so in limestones. Fractures and solution channels along fractures allow infiltration in local areas. Runoff moderate to high on shales, less so on sandstones and limestones. Erodibility moderate in shales by gully wash and stream scour, slight by sheet wash.

GROUND WATER CHARACTERISTICS: Permeability generally poor, may be fair at base of weathered zone, moderate through sandstones and in areas of solution channels. Water table unknown, probably varies. Water quality probably mineralized.

WASTE DISPOSAL: Septic systems generally fair to poor, percolation rates too slow. Risk of polluting ground water source in sandstone and limestone. Dump sites fair to good. Good in thick shale units. Fair to poor in sandstone and limestones where there is ground water pollution hazard.

FOUNDATION STABILITY: Fair. Shales may be expansive in part.

SLOPE STABILITY: Expansive, in part, susceptible to low angle slumping and slope failures. Beds dipping into cuts may fail.

RELATED GEOLOGIC HAZARDS: Formation is susceptible to slope failures and may contain expansive clays in part.

KNOWN AND POSSIBLE RESOURCES: Suitable for most construction and non-construction purposes such as sanitary land fill layering, some road fill, etc.

M1
Leadville Limestone

PHYSICAL DESCRIPTION: Consists of two members in Eagle County. The lower sandstone unit, called the Gilman Sandstone member, ranges from 10 to 50 feet in thickness and is discontinuous in some areas. It is composed of thin and uneven beds of grayish-brown medium-grained calcareous sandstone. The lower few feet consist of a light-gray, sandy, dolomite breccia that fills depressions in the underlying Dyer Dolomite. Above the Gilman member is about 75 feet of dense, hard, locally silicified dark-gray lithographic limestone. It is generally evenly massive bedded except the lower units that are thin and contain limestone pebbles. The thickness may range between wide limits in some areas because of post Leadville erosion. Beds are continuous.

TOPOGRAPHIC EXPRESSION: Forms prominent ridges and cliffs.

WEATHERING CHARACTERISTICS: Gilman sandstone weathers to a yellowish-brown sand. The main dolomitic limestone unit has a characteristic bluish-gray color with even smooth surfaces. In some of the nearby mining districts it is hydrothermally altered.

WORKABILITY: Excavation difficult, blasting required. Compaction difficult, must be crushed and thoroughly mixed with binder before emplacement. Drilling difficult.

DRAINAGE AND ERODIBILITY: Infiltration slow except through fractured and jointed areas and solution cavities. May be moderate in altered Gilman sandstone member. Erodibility negligible by sheet wash, gully wash, slight by stream scour. Some solution. Runoff high.

GROUND WATER CHARACTERISTICS: Permeability negligible except through fractures and solution cavities. May be fair in altered sandstone. Water table varies greatly from place to place and only occurs in fractured zones. Well yield not developed because of solution cavities and karst upper surface. Is a good aquifer in other areas of the state. Quality of water mineralized and hard, with domestic, stock and industrial use.

WASTE DISPOSAL: Septic systems poor, great hazard of polluting widespread ground water supply. Dump sites poor, difficult to excavate.

FOUNDATION STABILITY: Excellent.

SLOPE STABILITY: Excellent.

RELATED GEOLOGIC HAZARDS: Rockfall hazard near cliffs, subsidence in some areas where solution cavities are developed. Block slides may occur along bedding planes on steep dip slopes.

KNOWN AND POSSIBLE RESOURCES: Limestone could be a source of good quality aggregate and agricultural lime. Large deposits of lead and zinc with associated gold, silver and copper have been mined in nearby areas. These deposits were found in hydrothermally altered areas.

Dc
Chaffee Formation

PHYSICAL DESCRIPTION: Consists of two members; the Dyer Dolomite and the Parting Quartzite. The Dyer member is uniformly thin bedded, very finely crystalline, dense, hard, gray dolomite. Unit thickness varies locally from 75 to 150 feet. The upper portion of the Parting Member is a white medium to coarse grained quartzitic sandstone. It is usually massive and crossbedded with conglomeratic lenses. Bedding is massive and uneven, the lower 5 to 10 feet consists of a gray shale. The Parting Member thins towards the Gore Range and thickens southwestward to about 100 feet in thickness.

TOPOGRAPHIC EXPRESSION: Forms prominent ridges and outcrops.

WEATHERING CHARACTERISTICS: Weathered surfaces of the Dyer are light brown to light gray.

WORKABILITY: Excavation difficult, blasting may be required. Compaction, should be crushed and mixed with binder. Drilling difficult.

DRAINAGE AND ERODIBILITY: Infiltration negligible to slow, slow through fractured and jointed zones. Runoff moderate to high, depending on slopes. Streams may be joint controlled. Erodibility low by sheet and gully wash and stream scour.

GROUND WATER CHARACTERISTICS: Permeability generally low except along joints and in fractures zones where it may be moderate. Water table not known. Well yield undeveloped. Water quality unknown.

WASTE DISPOSAL: Septic systems poor, percolation rates too low. Dump sites poor, excavation difficult.

FOUNDATION STABILITY: Excellent.

SLOPE STABILITY: Good. Hazard of rockfall if bedding planes dip into steep cuts and jointing is prominent.

RELATED GEOLOGIC HAZARDS: Rockfalls are hazard near cliffs.

KNOWN AND POSSIBLE RESOURCES: Parting quartzite member could be useful as crushed aggregate. Suitable for most construction and non-construction purposes.

Oh
Harding Quartzite

PHYSICAL DESCRIPTION: Consists of an upper unit of primarily white, medium-grained vitreous orthoquartzites. The lower few feet consist of irregular brown, dolomitic and calcitic cemented sandstone beds with conglomeratic lenses. The beds in the upper unit are massive and occasionally cross-bedded. The beds in the lower unit are lenticular and cross-bedded. Yellowish gray-green sandstone is locally interbedded with the quartzite. The formation is about 50 feet thick but thins abruptly to the west and southeast.

TOPOGRAPHIC EXPRESSION: Resistant unit that forms ridges.

WEATHERING CHARACTERISTICS: Weathers to a gray sandstone. Angular blocks at base of cliff.

WORKABILITY: Excavation difficult, blasting may be required. Compaction, material will have to be crushed and mixed with binder before emplacement. Vibratory compactors suggested. Drilling difficult.

DRAINAGE AND ERODIBILITY: Infiltration negligible in upper quartzite, slight in underlying sandstone. Probably best in fractured and jointed material. Runoff moderate to high. Erodibility slight by sheet and gully wash, moderate by stream scour.

GROUND WATER CHARACTERISTICS: Permeability poor, may be fair in fractured zones and poorly cemented sandstones. Water table unknown, probably varies. Well yield undeveloped. Water quality not known.

WASTE DISPOSAL: Septic systems poor, difficult to excavate, percolation too slow. Dump sites poor, excavation difficult.

FOUNDATION STABILITY: Excellent. Blocks may fall into excavations.

SLOPE STABILITY: Rocks dipping into steep cuts may fall along bedding or jointing.

RELATED GEOLOGIC HAZARDS: Rockfall hazard near base of cliffs.

KNOWN AND POSSIBLE RESOURCES: Upper unit may be good riprap material and building stone.

Ꞓp
Peerless Formation

PHYSICAL DESCRIPTION: The composition is highly varied but, in general, is a brown, sandy dolomite, with streaks and laminae of greenish-gray or dark red dolomite. The dolomite grades laterally and vertically into dolomitic sandstone. Brown or gray shale is interbedded with the dolomite in the middle parts of the formation and becomes predominant at the top. The dolomite beds are thin and lenticular. The sandstone beds are usually more massive, and show some crossbedding. The thickness ranges from 35 to 112 feet.

TOPOGRAPHIC EXPRESSION: Moderately resistant unit forming low rounded ridges.

WEATHERING CHARACTERISTICS: Weathers to dark-to-light reddish-brown.

WORKABILITY: Excavation very difficult. Drilling and blasting required.

DRAINAGE AND ERODIBILITY: Infiltration slight, may be moderate in fractured and jointed zones. Runoff moderate to high. Erodibility slight by sheet and gully wash, moderate by stream scour.

GROUND WATER CHARACTERISTICS: Permeability poor, may be fair in fractured zones and poorly cemented sandstone. Water table unknown, probably varies. Well yield undeveloped. Water quality unknown.

WASTE DISPOSAL: Septic systems poor, excavation difficult, percolation slow. Dump sites poor, excavation difficult.

FOUNDATION STABILITY: Excellent. Blocks may fall into excavations.

SLOPE STABILITY: Bedding dipping into cuts may cause failures of jointed bedrock.

RELATED GEOLOGIC HAZARDS: Rockfall hazard near base of steep slopes. Bedrock may fail where bedding and joints dip into cuts.

KNOWN AND POSSIBLE RESOURCES: Suitable for most construction and non-construction purposes.

Ꞓs
Sawatch Quartzite

PHYSICAL DESCRIPTION: The Sawatch quartzite consists of three lithological units. The lower unit is a medium-grained, vitreous, white, orthoquartzite; the middle unit is alternating beds of medium-grained, dolomitic, brown sandstone and white orthoquartzite; and the upper unit is fine-grained, vitreous, white orthoquartzite. The quartzites are medium-bedded to massive, and show some cross-bedding. The middle zone is thin bedded; and the individual dolomitic beds are lenticular, grading into quartzite laterally. The thickness of the formation ranges from 190 to 216 feet, but on the average is about 200 feet thick.

TOPOGRAPHIC EXPRESSION: The upper and lower zones are highly resistant and form prominent ridges across divide areas and cliffs where the beds are more gently dipping. The middle zone forms a steep slope between cliffs.

WEATHERING CHARACTERISTICS: The upper and lower zones weather to angular light brown or gray cliffs or large blocks. The middle zone weathers to a dark brown steep slope.

WORKABILITY: Excavation very difficult, drilling and blasting required. Compaction, rock would have to be crushed and mixed with binder. Drilling difficult.

DRAINAGE AND ERODIBILITY: Infiltration negligible through rock, slow to moderate through fractures. Runoff rapid to moderate. Erodibility very resistant.

GROUND WATER CHARACTERISTICS: Permeability slight to low, low in fractured and jointed areas. Water table unknown, may be present in fractured areas. Well yield undeveloped, probably unreliable.

WASTE DISPOSAL: Septic systems unsatisfactory, excavation and burial difficult, no infiltration. Dump sites unsuitable chiefly because excavation for sanitary layering difficult.

FOUNDATION STABILITY: Excellent.

SLOPE STABILITY: Rockfall hazard. Blocks may fall into cuts if bedding and jointing dip into cuts.

RELATED GEOLOGIC HAZARDS: Rockfall hazard near edge and base of cliffs.

KNOWN AND POSSIBLE RESOURCES: May be good riprap, crushed aggregate and road aggregate. Suitable for construction and non-construction purposes.

p€
Igneous and Metamorphic Rocks

PHYSICAL DESCRIPTION: The Precambrian rocks include granites, schists, gneisses and lamprophyres of the Sawatch and Gore Ranges. The rocks are fine-to-coarse-grained, with interlocking granular borders. Most have a pronounced layering or foliation, are dense, hard, well jointed and locally sheared. Grain-sizes range from 1 mm to 5 mm, with coarse grains to 10 mm locally. The different mineralogic units generally cover large areas but individual rock types may be discontinuous over short distances.

TOPOGRAPHIC EXPRESSION: Rugged, rolling hills and mountains, with numerous low rounded exposures. Forms the cores of the Gore and Sawatch Ranges.

WEATHERING CHARACTERISTICS: Extremely resistant and is generally lichen covered; soils when present are very clayey sand, indicating decomposition of the feldspars. May develop good weathered horizon in sheared zones.

WORKABILITY: Excavation very difficult in unweathered rock, generally requires blasting. Moderately easy to moderately difficult in weathered rock. Commonly can be excavated with rippers and scrapers, locally with front end loaders. Compaction very difficult. Material would have to be crushed and mixed with binder before emplacement. Drilling very difficult.

DRAINAGE AND ERODIBILITY: Infiltration negligible into rock, moderate to slow through widely spaced fracture systems, moderate into fracture zones of faults. Runoff rapid to moderate. Erodibility generally moderately resistant, moderately erodable where weathered.

GROUND WATER CHARACTERISTICS: Permeability moderate to high near surface through fractures and weathered rock, decreases to negligible at 200 to 400 feet depth. Water table may be present locally, mainly in fractures and weathered rock, depth varies, depends on extent of weathering and openness and continuity of fractures. Well yield generally small to very small, 0-3 gpm, may be much greater in fracture zones and shear zones. Depends on openness and continuity of fractures. Quality of water fair to good, locally moderately hard. Poor to fair source for domestic and stock wells.

WASTE DISPOSAL: Septic systems locally unsatisfactory, percolation too slow and material for burial lacking except where well weathered and decomposed. Risk moderate to high for pollution of nearby water supplies through fractures. Dump sites, unsuitable chiefly because excavation for sanitary layering difficult, and material too permeable. Access locally difficult with slight to moderate risk of polluting nearby water supplies. Sealing of fractures before use adviseable.

FOUNDATION STABILITY: Excellent. Caution advised within 25 feet of margin of excavation because of slope instability and rockfalls.

SLOPE STABILITY: Mostly good, risk moderate of rockfalls and small rock slides along steep slopes. Cuts locally controlled by altitude of foliation, compositional layering and fractures. Hazardous where these are undercut. Stable highway backslopes cut nearly vertical are common.

RELATED GEOLOGIC HAZARDS: Rockfall or rockslide hazard, avalanche hazard high above timberline.

KNOWN AND POSSIBLE RESOURCES: Possible source of aggregate and riprap. Generally satisfactory for most construction and non-construction purposes. Gold and silver deposits in quartz viens have been worked intermittently over parts of the region.

SOURCE: Appendix I and Figure 8, Map of Bedrock Geology and Known or Potential Mineral Resources, were compiled by William A. Gallant and Judi C. Culver of Charles S. Robinson & Associates, Inc., at the request of Camp Dresser & McKee. The information was compiled from existing literature, aerial photography and from field investigations made during the summer of 1975. All information was edited and revised for this project during February, 1976.

APPENDIX J

Explanation of Geologic Hazard and Engineering Geology Map

- Geologic Hazard. Geologic hazard areas include slope failure conditions where landslides or rockfalls are a problem, floodplains, swamps and debris fans where frequent flooding or hydrocompaction may be a problem. Specific explanations of each hazard are included below:

ls - Landslides. Mass movements where there is a distinct surface of rupture or zone of weakness. Subtypes indentified and described below.

sfc - Slope failure complex. Large areas of failure of surficial and bedrock units. May consist of a combination of slope failure types.

ds - Debris slides. Landslide type consisting primarily of surficial material.

ac - Accelerated soil creep. Areas of colluvial slope that is moving downslope at a relatively rapid rate.

rf - Rockfall hazard. Areas of either active or potential falling, rolling or sliding of large bedrock blocks.

pfp - Physiographic floodplain. The portion of a major stream valley where erosion and deposition presently occurs and is generally subject to flooding on an approximate 25-year cycle.

sw - Swamps. Areas where poor drainage or high ground water cause permanent or seasonal saturation. Soils may be compressable because of high organic content.

dfa - Debris fan. Areas of possible recurrent flooding, debris flows and hydrocompaction.

shy - Subsidence. Areas that may be susceptible to subsidence due to hydrocompaction in low density soils.

- Denotes the Eagle Valley Evaporite Sequence. This sequence is included as a geologic hazard because the gypsum beds within these rocks are highly susceptible to solution, with resulting subsidence of the topography. Other rock and soil units in this area exhibit low strength and are prone to landslides after subsidence has occured. The soils also tend to be highly corrosive to steel and moderately corrosive to concrete. Corrosivity problems in this area are more significant than in other areas of the District.

SUGGESTED ENGINEERING GEOLOGY CATEGORIES

1

Basic geologic and engineering investigations of area as required by Senate Bill 35, adequate for development planning and generally for construction site selection.

A. High stable gravel covered terraces above the physiographic floodplain. Emphasis on, but not limited to, groundwater, surface and subsurface drainage, composition and characteristics of underlying bedrock that may be penetrated and possible resource evaluation.

B. Stable colluvium or bedrock on flat to gentle slopes. Emphasis on, but not limited to, surface and subsurface drainage and slope stability.

C. Stable glacial material on flat to gentle slopes. Emphasis on, but not limited to, surface and subsurface drainage, slope stability and possible resource evaluation.

2

General geologic and engineering investigations of area required for development planning for each construction site.

A. Stable colluvium or bedrock on gentle slopes that may have a thin gravel cap. Emphasis on, but not limited to, surface and subsurface drainage, composition and characteristics of near surface bedrock and slope stability.

B. Stable glacial deposits on gentle to moderate slopes. Emphasis on, but not limited to, surface and subsurface drainage, slope stability and possible resource evaluation.

3

Detailed geologic and engineering investigations of entire area is required for development planning and for selection of construction sites.

A. Stable colluvium and bedrock on gentle to moderate slopes. Emphasis on, but not limited to, surface and subsurface drainage, slope stability and possible resource evaluation.

B. Thick colluvium on gentle to moderate slopes. Emphasis on, but not limited to, expansive and

corrosive soils, surface and subsurface drainage and hydrocompaction.

C. Fine grained tailings deposit on flat to moderate slopes. Emphasis on, but not limited to, slope stability, corrosive material, surface and subsurface drainage.

D. Debris fans. Gentle thick collovial slopes consisting of fine to coarse rounded material. Emphasis on, but not limited to, surface and subsurface drainage, frequency and control of mudflows and debris flows, hydrocompaction and possible resource evaluaticn.

4

Detailed geologic and engineering investigations required for entire area for development planning and some construction sites may require specialized geologic and engineering investigations for design purposes.

A. Thin glacial deposits overlying potentially unstable moderate to steep colluvial and bedrock slopes. Emphasis on, but not limited to, slope stability, surface and subsurface drainage.

B. Stable colluvium and bedrock on moderate to steep slopes. Emphasis on, but not limited to, slope

stability, rockfall hazard, expansive and corrosive soils and surface and subsurface drainage.

C. Potential rockfall areas associated with talus slopes. Medium to coarse blockly material deposited by rockfall at the base of cliffs. Emphasis on, but not limited to, rockfall hazard, slope stability, surface and subsurface drainage.

5

Detailed geologic and engineering investigations of entire area required for development planning and specialized investigations required for specific construction sites.

A. Rockfall hazard areas and talus on moderate to steep bedrock and colluvial slopes. Emphasis on, but not limited to, slope stability, surface and subsurface drainage and expansive and corrosive soils.

B. Debris slides, bedrock slides and slope failure complexes composed of poorly sorted thin to thick, fine to coarse colluvial and bedrock on gentle to steep slopes. Emphasis on, but not limited to, slope stability, surface and subsurface drainage, corrosive and expansive soils.

C. Stable or potentially unstable colluvium or bedrock on moderate to steep slopes. Emphasis on, but not limited to, slope stability, surface and subsurface

drainage, debris flows in higher mountain areas.

D. Potentially unstable colluvium or gypsiferous bedrock on gentle to steep slopes. Emphasis on, but not limited to, hydrocompaction, subsidence due to solution, surface and subsurface drainage, corrosive and expansive soils, and slope stability.

6

Extensive detailed geologic and engineering investigations necessary for development planning. Most of the area within this classification may not be suitable for permanent structures.

A. Debris slides and slope failure complexes made up of unsorted thick colluvial material on moderate to steep unstable or metastable slopes. Emphasis on, but not limited to, slope stability, surface and subsurface drainage, corrosive and expansive soils.

B. Areas of accelerated creep composed of colluvium or bedrock on steep unstable or metastable slopes. Emphasis on, but not limited to, slope stability, surface and subsurface drainage, corrosive and expansive soils.

7

Extensive detailed geologic and engineering field investigations required for development planning. Utility corridors, temporary structures and some permanent structures may utilize parts of these areas after extensive investigations and design for the specialized problems involved.

A. Physiographic floodplain where erosion and deposition is presently active and is generally subject to recurrent flooding on an approximate 25-year cycle. Emphasis on, but not limited to, frequency, depth and control of water and water entrained debris.

SOURCE: Appendix J and Figure 7 Geologic Hazards and Engineering Geology Map, were compiled by William A. Gallant and Judi C. Culver of Charles S. Robinson & Associates, Inc., at the request of Camp Dresser & McKee. The information was compiled from existing literature, aerial photography and from field investigations made during the summer of 1975. All information was edited and revised for this project during February, 1976.

APPENDIX K

Explanation of Soil Classifications

GEOMORPHIC STRUCTURE

The letters which appear beside the soils classifications denote the geologic origin of the landform on which that soil has formed. An explanations of these geomorphic denotations appears below:

Qaf - Denotes soils which have formed on the surface of alluvial fans, and/or slope wash. The topographic features are formed from sediments dropped by streams or sheet erosion waters as their gradiant decreases near valley bottoms until they cannot maintain enough current speed to carry their full sediment load. Part of the sediments are then deposited as alluvial fans in stream beds or as slope wash at the bottom of steep slopes where sheet erosion occurs. The coarse portion of soils derived atop slope wash deposits can be expected to be angular to sub-angular because of their short transportation distance. The coarse portion of soils derived from alluvial fan surfaces can be expected to be sub-angular to sub-rounded because of their longer transportation distance and because of the smoothing action of water. The pH of these soils should be near neutra , with widely varied mineral content due to the diverge. source materials within stream transported materials.

Qt - Refers to soils formed on the surface of old stream terraces. These stream terraces were the floodplains

of ancestral Eagle River and Gore Creek, before they eroded their valleys down to their present elevations. The coarse portion of soils formed on old stream terraces can be expected to be sub-rounded, rounded and well-rounded due to considerable tumbling and smoothing which they received before deposition on the floodplain of a major ancient stream. The pH of these soils should be near neutral, with widely varied mineral content due to the divergent source materials within stream transported materials.

Qfp - Denotes soils which have formed on the surface of the modern floodplain of the Eagle River and Gore Creek. The coarse portion of these soils may be expected to be sub-rounded, rounded and well-rounded due to considerable smoothing action of water before deposition on the floodplain of a major stream. The pH of these soils should be near neutral, with widely varied mineral content due to the divergent source materials within stream transported materials. Water table in these soils can be expected to be high, but varies with season and stream level.

Qsw - Soils in these areas have formed in swamps, where the water table intersects the land surface. Soils formed in this environment can be expected to be damp and poorly-drained with a high to moderate organic content and few coarse components. The pH of these soils can be expected to be less than 7 due to formation of organic acids from decaying plant material.

Qcu - Refers to soils formed in unstable colluvium on the surface of landslide complexes such as bedrock slides, surficial slides and talus slopes. The coarse portion of these soils can be expected to be angular due to their very short transportation distance. Any rounding in large fragments would be due almost entirely to in situ weathering. Some physical and chemical soils characteristics may be derived from parent bedrock material in which the slide originated. For example, soils derived over landslides or sinkholes in the Eagle Valley Evaporite Sequence are likely to exhibit high sulfate and salt content due to the chemical nature of the parent material. Interpretations of soils formed over Qcu areas should be made in conjunction with Figure 8 , Bedrock Geology Map.

Qc - Denotes soils which have formed from colluvium, or in situ weathering of bedrock materials. The coarse portion of soils derived from colluvium can be expected to be angular, except for those fragments which received rounding prior to lithification of the bedrock materials. These soils are likely to show chemical and physical characteristics which are similar to those of the parent bedrock material. For example, soil formed over limestone or dolomite beds is likely to have an alkaline pH because of high carbonate content; soil formed over shale is likely to have fewer coarse fragments than soil formed from sandstone or conglomerate. Interpretations of soils formed over Qc areas should be made in conjunction with Figure 8 , Bedrock Geology Map.

SOIL TYPE

Soil Type 1 CL-GC

PHYSICAL DESCRIPTION: This soil group includes unnamed fine sandy loams, stony sandy loams, and stony clay loams, as designated by the U. S. Soils Conservation Service. The most frequent occurrence of this soil group is in the eastern portion of the area on the steep mountainsides and terraces of Gore Creek. The majority of them are deep and well-drained, becoming increasingly stony with depth. These soils characteristically have rapid or moderately rapid permeability (2.0 to 20.0 inches/hour), and erosion hazard is slight to moderate with their natural vegetation cover. The pH of these soils ranges from 6.1 to 7.3 on northern exposures and from 6.6 to 8.4 on southern exposures.

WORKABILITY: Workable with most standard construction equipment. Excessive stoniness can be a problem. A majority of areas have more than thirty percent gravel, cobble or stone. Material normally must be graded and sorted before use as fill.

DRAINAGE/ERODIBILITY: Because of rapid permeability, runoff and associated sheet erosion danger is slight to moderate. Because of the high percentage of coarse fragments, these soils tend to lose their cohesiveness when the natural root mat is destroyed. After destruction of natural root mat, erosion hazard becomes moderate to high.

SUITABILITY FOR:

Septic Systems: Poor. Rapid permeability allows excess seepage and danger of groundwater contamination. Large stones hinder excavation.

Landfill: Poor. Due to seepage and large stones.

Topsoil: Poor. Topsoil is thin and stony. Stoniness increases with depth.

Foundations: Fair. Stones hinder excavation. Steel corrosivity high. Concrete corrosivity low to moderate in more alkaline areas.

Sand and Gravel: Poor to fair. Many areas too stony. Some areas of poorly graded, very clayey gravel on stream terraces.

Roadfill: Poor to fair. In many areas large stones must be removed.

Irrigation: Poor. Limiting factors are high slope angle, stoniness and/or urban development. Areas which might have been suitable for irrigation have already been developed as urban or suburban/recreational lands.

Soil Type 2 CL-SC

PHYSICAL DESCRIPTION: This soil group consists of unnamed sandy loams, sandy clay loams and clay loams, according to the U. S. Soils Conservation Service. The soil group occurs mainly on alluvial fans and stream terraces, and occasionally mountain sideslopes. The soil includes occasional gravelly lenses. Permeability is rapid to moderately rapid (2.0 to 20.0 inches/hour) and soils are deep and well drained. Erosion hazard is low to moderate because of vegetation cover and predominant gentle slopes (less than 15%). The pH of these soils ranges from 6.1 to 7.8.

WORKABILITY: Workable with most standard construction equipment. Workability is generally good. Some slumping into excavations may be encountered on slopes over 15%.

DRAINAGE/ERODIBILITY: Erosion hazard is low to moderate because of gentle slopes, rapid infiltration rates, and heavy rootmats. Erosion hazard would become moderate upon removal of natural root mat.

SUITABILITY FOR:

Septic Systems: Fair to good. Becomes fair to poor on slopes over 10%. Limiting factor is permeability, rate and slope.

Landfill: Fair to poor. Becomes poor on slopes over 10%. Limiting factor is increasing seepage with increasing slope.

Topsoil: Good. Becomes fair to poor with increasing stoniness and thinner soil on slopes over 10%.

Foundations: Good to fair. Becomes fair to poor on slopes over 10% and in occasional very stony lenses. Moderate shrink swell and frost heaving may be encountered. Steel corrosivity is high. Concrete corrosivity is low.

Sand and Gravel: Very poor. Abundant fines.

Roadfill: Fair to poor. Limiting factors are shrink-swell and frost action. Stoniness is a limiting factor on slopes over 15%.

Irrigation: Fair to poor. Soils on gentle slopes may be adequate for irrigation, but these soils lie almost entirely in areas of urban or suburban developement.

Soil Type 3 CL-SC

PHYSICAL DESCRIPTION: This soil group includes the Libeg Cobbly Loam, the Jerry Loam, the Ansel-Anvik Association, and two unnamed loamy to sandy loamy soils, as designated by the U. S. Soils Conservation Service. The most frequent occurrence of these soils is in the western portion of the Sanitation District, on mountain slopes under Spruce-Fir vegetation (Ansel-Anvik) and on grassy rangeland slopes. The soils are generally deep and well-drained and permeability is generally moderate (0.6 to 2.0 inches/hour). Erosion hazard is slight to moderate when the land retains its natural root cover. Soils are generally neutral with pH values ranging from 6.1 to 7.8. Color ranges from reddish browns in the Libeg Association to grayish or yellowish-brown in the Ansel-Anvik Association.

WORKABILITY: Workable with most standard construction equipment. Excessive stoniness can be a problem in some areas, but is confined generally to fifty percent or less of these soils. A high clay content in the topsoil layer may cause surface layers to slump into excavations on slopes.

DRAINAGE/ERODIBILITY: Because of moderate permeability and water transmission, the danger of sheet erosion is slight to moderate. Because these soils tend to lose their cohesion when natural root mat is destroyed, erosion danger is moderate to high in barren areas.

SUITABILITY FOR:

Septic Systems: Fair to poor. Limiting factors are stony areas, and areas of slope over 15%, with associated greater permeability. In many level areas, sufficient clay materials are available for liner.

Landfill: Fair to poor. Permeability is too great in most areas, creating danger of groundwater contamination. Stoniness hinders excavation in many areas.

Topsoil: Poor to fair. Limiting factors are thin topsoil layer, stoniness, excessive clays and slope.

Foundations: Good to fair. Large stones inhibit excavation. Dangers of shrink-swell and frost heave in surface clays is moderate. Suitability for foundations becomes fair to poor on slopes over 15%. Clay may slump into excavations on steep slopes. Corrosivity of steel is high. Corrosivity of concrete is moderate.

Sand and Gravel: Poor. Excessive fines.

Roadfill: Poor to fair. Limiting factors are low strength, large stones, frost action and shrink-swell.

Irrigation: Poor. Limiting factors are slope and stoniness.

Soil Type 4 CL-SC

PHYSICAL DESCRIPTION: This soil type includes the Burnette-Libeg Association and other unnamed loams and clay loams, according to the U. S. Soil Conservation Service. The soil group consists of sandy clay loams, clay loams and clays and occurs on stream terraces and alluvial fans in the western portion of the sanitation districts. The soils are generally deep and well-drained. Permeability is moderate to slow. Soils are formed from stream alluvium or glacial outwash, and are generally neutral despite the gypsiferous bedrock which usually underlies them at depth. Color is dark brown to black loam.

WORKABILITY: Workable with most standard construction equipment. Stoniness may be a problem in some areas. High clay content in the topsoil layer may cause surface layers to slump into excavations on slopes.

DRAINAGE/ERODIBILITY: Becuase of a generally good root mat, low angle slopes and slow surface runoff, erosion hazard is slight.

SUITABILITY FOR:

Septic Systems: Fair. Limiting factors are a slow permeability rate and stoniness in some areas. Becomes poor on slopes over 8%.

Landfill: Good to fair. Moderate permeability in some areas may require a liner to guard against pollution of groundwater through seepage. Large stones may inhibit excavation and fill in some areas, especially on slopes over 8%.

Topsoil: Poor. Limiting factors are high clay content and thinness.

Foundations: Fair to poor. Limiting factors are low strength, high shrink swell potential, frost heave, and stoniness. Soils may slump into excavations. Corrosivity of steel is high. Corrosivity of concrete is low.

Sand and Gravel: Very poor. Excessive fines.

Roadfill: Poor to fair. Limiting factors are low strength, frost action and shrink swell potential.

Irrigation: Fair to poor. Some irrigation and farming has been performed historically, but most potentially irrigable land is now committed to urban development. Limiting factors are poor topsoil and stony areas.

Soil Type 5 GC-SC

PHYSICAL DESCRIPTION: This soil type includes the Zillman-Unnamed cobbly loam complex and other unnamed gravelly loams, according to the U. S. Soil Conservation Service. The soil group consists of cobbly and sandy loams and occurs on stream terraces and alluvial fans along the Eagle River where water action has been sufficient to form well-graded, well-rounded gravel deposits. The soil is moderately deep over cobble and gravel, well-drained, and permeability is rapid. The pH is generally neutral.

WORKABILITY: Can be worked with most standard construction equipment. Excessive stoniness can be a problem.

DRAINAGE/ERODIBILITY: Surface runoff is slow and erosion hazard is slight because of a rapid permeability rate and usually gentle slope.

SUITABILITY FOR:

Septic Systems: Poor. Large stones. Rapid permeability may present a pollution hazard.

Landfill: Poor due to seepage and large stones.

Topsoil: Poor due to large stones.

Foundations: Poor to fair. Large stones are a limiting factor. Cutbanks tend to cave. Becomes poor on slopes exceeding 15%. Steel corrosivity is high. Concrete corrosivity is moderate to low.

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Sand and Gravel: Good. Existing gravel pits occur in this soil type.

Roadfill: Fair. Large stones are the limiting factor.

Irrigation: Very poor. Limiting factors are slope and stoniness.

Soil Type 6 CL-SC, GC

PHYSICAL DESCRIPTION: This soil group includes unnamed sandy, silty and channery loams and the Clapper Stony Loam, according to U. S. Soils Conservation Service nomenclature. These gypsiferous soils have formed over the Eagle Valley Evaporites. Soils are used for rangeland. Permeability is moderate to moderately rapid, runoff is moderate to high and erosion hazard is high. Size gradation of the soil is usually sandy and silty clay with some clayey sand, but some soil on breaks and ridges is extremely stony. The pH of these soils is 7.4 to 8.4.

WORKABILITY: Workable with most standard construction equipment. Piping, sinkholes and caving of solution cavities may present problems.

DRAINAGE/ERODIBILITY: Gypsiferous soils tend to be dry and flaky with low available water capacity (0.10 to 0.17 inches/hour). Because of the dry, flaky nature of the soil, erosion hazard is high, despite moderate to moderately rapid infiltration rates. Collapse of solution cavities can cause disruption of drainage patterns and resultant high erosion danger. Sediment yield risk when vegetation cover is removed becomes very high.

SUITABILITY FOR:

Septic Systems: Good. Care should be taken to avoid sinkholes or solution cavities. Becomes fair to poor on slopes over 8%.

Landfill: Poor. Permeability rates create hazard of groundwater pollution.

Topsoil: Poor. Topsoil is thin and stony. Alkalinity may be a borderline problem in some areas.

Foundations: Fair to good. Cutbanks tend to cave because of low soil strength. Some frost heave may occur, although shrink swell potential is low. Becomes fair to poor on slopes over 8%. Care should be taken to avoid areas of sinkholes or subsidence. Concrete corrosivity is moderate. Steel corrosivity is high.

Sand and Gravel: Very poor.

Roadfill: Fair to poor. Soils exhibit low strength. Some frost heave may occur.

Irrigation: Very poor. Limiting factors are alkalinity, high gypsum content and slope.

Soil Type 7 GM-ML

PHYSICAL DESCRIPTION: This is deep, poorly-drained, sandy loam with lenses of stony loam, loamy sand, sand, gravel and areas of marshland rich in organic content. No U. S. Soils Conservation Service nomenclature has been given this soil type. This soil type occurs throughout the Sanitation District on the modern floodplain of the Eagle River and Gore Creek. Permeability is rapid, but a high water table throughout the year inhibits soil drainage. The pH is generally neutral, except in areas of high organic content where pH is slightly acid.

WORKABILITY: Workable with most standard construction equipment. Pumping may be required due to high water table. Gravel and boulder content increases to more than 35% percent below 25 inches.

DRAINAGE/ERODIBILITY: Erosion hazard is generally low because of low slope angle, except during periods of flood when hazard of stream bank erosion is high. Flood hazard is seasonal.

SUITABILITY FOR:

Septic Systems: Very poor. High water table would be severe groundwater pollution hazard.

Landfill: Very poor. High water table would be severe groundwater pollution hazard.

Topsoil: Very poor. Poor drainage and large stones are limiting factors.

Foundations: Very poor. High water table and flood hazard. Steel corrosivity is high. Concrete corrosivity is moderate.

Sand and Gravel: Fair to good. Gravel pits would have to be pumped due to high water table.

Roadfill: Fair to poor. Wetness and large stones are limiting factors.

Irrigation: Very poor. Poor drainage and stoniness are limiting factors.

Soil Type 8 ROCKLAND

PHYSICAL DESCRIPTION: This unit consits of rough broken land, stony land and rockland, according to the U. S. Soil Conservation Service. There is very little actual soil present. Much of the land is broken by intermittent drainage channels, and sparse vegetation may grow in a few more favorable areas. Rockland areas occur in the center portions of the sanitation districts on very steep talus and wasterock slopes. Soils, where present, are very shallow and permeability is very slow because bedrock is at or near the surface. Because more than half of these areas consist of exposed bedrock, erosion hazard is slight and runoff is high.

WORKABILITY: Ripping or blasting may be necessary in many areas, depending upon quality of bedrock. In most areas, must be crushed and mixed with binder for compaction.

DRAINAGE/ERODIBILITY: Runoff is high due to minimal permeability of bedrock. Erosion hazard is very low due to hardness of bedrock and absence of soil in most areas.

SUITABILITY FOR:

Septic Systems: Very poor. Lack of soil and resultant very slow permeability is unsuitable.

Landfill: Very poor. Bedrock fractures near surface present hazard of groundwater contamination. Excavation would be very difficult in almost all areas.

Topsoil: Very poor. Thin to nonexistent in most areas.

Foundations: Very poor. Ripping or blasting would be required in most areas.

Sand and Gravel: Very poor. Fragments too large or solid bedrock.

Roadfill: Very poor. Fragments too large or solid bedrock.

Irrigation: Very poor. No soil.

SOURCE: Appendix K and Figure 9, Map of Soils and Surficial Deposits, was compiled by Judi C. Culver of Charles S. Robinson & Associates, Inc. at the request of Camp Dresser & McKee. The information was compiled in February, 1976, from existing literature, aerial photography, and from field investigations made by the U. S. Soils Conservation Service.

APPENDIX L

AVERAGE AND EXTREME DISCHARGES FOR USGS STATIONS LOCATED ON THE EAGLE RIVER AND ITS TRIBUTARIES

STATION	DRAINAGE AREA Mi^2	YEARS OF DATA	MEAN ANNUAL DISCHARGE cfs^2	DISCHARGE $Ac\text{-}ft/yr^3$	PERIOD OF RECORD EXTREMES Maximum cfs	Maximum Date[4]	Minimum cfs	Minimum Date[5]
Eagle River at Red Cliff	70.00	45[1]	49.90	36,150	1,010	6-05-65	1.00	10-15-17
Wearyman Creek near Red Cliff	8.78	10	8.47	6,140	140	6-18-65	0.30	02-21-67
Turkey Creek near Red Cliff	23.90	12	22.10	16,010	515	6-17-65	ND[6]	--
Homestake Creek near Red Cliff	58.30	30[1]	38.80[7]	28,110[7]	1,300	6-24-18	0.60	01-25-15
Cross Creek near Minturn	33.50	14[1]	51.30	37,170	754	6-30-57	0.10	12-27-62 to 12-31-62
Gore Creek (upper station near Minturn)	14.30	20[1]	28.10	20,360	588	6-10-52	1.40	02-27-66 and 03-03-66 to 03-09-66
Black Gore Creek near Minturn	11.80	20[1]	16.50	11,950	365	6-07-52	0.90	02-22-68 and 1-30-70
Black Gore Creek near Vail	19.00	1	34.00	12,414	340	5-30-74	2.80	02-27-76
Bighorn Creek near Minturn	4.37	11	8.14	5,900	225	6-10-73	0.10	02-08-67
Pitkin Creek near Minturn	5.39	8[1]	10.00	7,240	126	6-24-71	0.24	10-29-72 and 11-01-72
Booth Creek near Minturn	6.03	10	11.30	8,190	182	6-21-68	0.20	02-08-67 and 01-29-70
Gore Creek at Vail	55.00	1	106.00	76,870	1,260	5-29-74	4.70	02-24-74
Middle Creek near Minturn	5.97	10	5.59	4,050	116	6-20-74	No Flow	Several
Red Sandstone Creek near Minturn	7.27	11	8.81	6,380	207	6-10-73	0.20	01-30-70
Beaver Creek at Avon	15.70	Very Fragmentary	--	--	122	5-29-74	1.50	08-09-11
Eagle River below Gypsum	944.00	28	569.00	412,200	6,580	6-11-52	110.00	02-21-55, 02-03-56, 12-26-62 and 12-27-62

[1]Indicates interrupted data accumulation; [2]Cubic feet per second; [3]Acre-feet per year; [4]Maximum flood flow recorded - instantaneous
[5]Minimum daily average flow for 24 hours; [6]ND = Not determined; [7]Based on 8 years data after completion of Homestake Diversion Tunnel

SOURCE: 1974 Water Resources Data for Colorado, Part 1, U.S. Geological Survey

APPENDIX M

SUMMARY OF CURRENT

DISCHARGE PERMIT LIMITATIONS

	UEVSD, before July 1, 1977	UEVSD, after July 1, 1977	Vail, before July 1, 1977	Vail, after July 1, 1977	Redcliff, before July 1, 1977	Redcliff, after July 1, 1977	New Jersey Zinc Company	Colo. Highway Dept. (typical)
BOD - 30 day avg. (mg/l)	30	30	30	30	30	30	-	-
BOD - 7 day avg. (mg/l)	45	45	45	45	45	45	-	-
SS - 30 day avg. (mg/l)	30	30	30	30	30	30	30	30
SS - 7 day avg. (mg/l)	45	45	45	45	45	45	-	45
Fecal Coliforms								
-30 day avg. (no./100 ml)	-	6000	-	6000	-	-	-	-
-7 day avg. (no./100 ml)	5000	12000	5000	12000	-	-	-	-
Total resid. chlorine (mg/l)	.1	.05	.5	.05	.2	.2	-	-
Ammonia - Dec.-Jul. (kg/day)	116[b]	116[b]	-	-	-	-	-	-
Ammonia - Aug.-Nov. (kg/day)	50[c]	50[c]	-	-	-	-	-	-
Oil and grease (mg/l)	10	10	10	10	10	10	-	10
Zinc (mg/l)	-	-	-	-	-	-	1	-
Iron (mg/l)	-	-	-	-	-	-	2	-
Soluble iron (mg/l)	-	-	-	-	-	-	.5	-
Cyanide (mg/l)	-	-	-	-	-	-	.025	-
Lead (mg/l)	-	-	-	-	-	-	.1	-
Manganese (mg/l)	-	-	-	-	-	-	2.5	-
Dissolved Aluminum								
-30 day avg. (mg/l)	-	-	-	-	-	-	-	1.0
-7 day avg. (mg/l)	-	-	-	-	-	-	-	1.5

a daily limit
b 245 lb/day
c 110 lb/day

APPENDIX N

Analysis of Recommended Sewerage System Improvements for Red Cliff

The background of the Red Cliff system has been included in Section VI.A. of this report. A study and report was recently prepared by Wright-McLaughlin Engineers on the sanitary sewer and sewage treatment system in Red Cliff. The report described the present state of the system and recommended that certain corrective measures be taken to upgrade its performance and efficiency. The Facilities Plan engineering consultant (M & I) has determined that the recommendations made in the report represent a reasonable and feasible solution for improving the system, and CDM concurs; therefore, this analysis will address the improvement plan prescribed in the Wright-McLaughlin report.

Summary of Existing Problems

The existing sewage collection and outfall system is subject to severe infiltration problems, which have been attributed largely to substandard construction and inadequate inspection. In addition, water service lines are bled into the sewers in order to prevent line freezing in the winter. As a result of this infiltration and inflow, sewage flows at the treatment plant are 3 to 4 times the amounts that would normally be expected from the known customers. It has been concluded that the sewer system is of little value in its present state.

The existing treatment plant is a package unit which operates on the contact-stabilization activated sludge process, and is designed to treat 70,000 gpd. Due to the high hydraulic loadings, the plant is not able to operate properly, and in fact, much of the reduction in discharged pollutant levels from normal domestic sewage can be attributed largely to dilution by the infiltration/inflow water. In addition, the plant is not designed with consideration for cold temperatures, adverse weather, operation simplicity, and safety.

Recommended Improvements

It is recommended that the existing sewer system undergo a rigorous rehabilitation program. Most of the lines must either be removed and replaced, relined with inserted polyethylene sleeves, or pressure grouted. Also, bleeder flows should be eliminated from the sewers and routed directly to streams or special bleeder service lines. Infiltration/inflow would not be completely eliminated, but flows would be reduced to a range between 60,000 and 100,000 gpd. The treatment plant is of adequate size for the present Red Cliff population as well as future projections through the year 1995. It is recommended that the facility be modified to operate on the conventional activated sludge principle, and that certain other improvements

be made, including grit removal, flow equalization, filtration, and additional capability for disinfection and sludge handling and disposal. Also the plant should be completely enclosed and handrails installed around the tanks. Improvements recommended are primarily in the interest of increased reliability, operability, minimum cost, and attaining an acceptable level of sewage treatment.

Treatment System Evaluation

Discharge Requirements: The Discharge Permit currently in effect will expire on September 30, 1976. The current permit is summarized in the following table:

	30 day Avg.	7 day Avg.	Daily Maximum
BOD	30 mg/l	45 mg/l	60 mg/l
Suspended Solids	30 mg/l	45 mg/l	60 mg/l
Coliforms	200/100 ml	400/100 ml	
Residual Chlorine			.2 mg/l

It is expected that most of these criteria will not change appreciably when the permit is renewed. Although highly restrictive in-stream chlorine residual limitations are currently proposed, a discharge of 0.2 mg/l should not cause the limits to be exceeded. Since this plant is small, its effect on stream waste load allocations will be minimal and it does not seem likely that restrictive limitations on ammonia or nutrient discharge will appear on the new permit.

Primary Treatment: Relocating the bar screen inside a building will allow better access for cleaning during the winter. A grit chamber is highly beneficial, particularly when primary settling is not provided. Grit removal protects pumps from abrasion and prevents grit buildup in the aeration basins, which can cause displacement of mixed liquor and reduce plant efficiency. Primary clarification customarily precedes aeration when the conventional activated sludge process is used, but as has been previously pointed out, may not be necessary when the wastewater is primarily domestic, does not contain excessive grease, and grit removal is provided. Conventional treatment is used successfully in Colorado at many locations without primary settling. Even though the plant will be operating in the conventional mode, it should be designed to require minimal attention. Exclusion of primary clarification will eliminate the production of primary sludge and the need for associated equipment, handling processes, and operator attention.

Secondary Treatment. The most ideal modification of the activated sludge process for a plant of this size would be the extended aeration concept, where the organic sludge is self-consuming, and only a small amount of inert sludge must be periodically wasted. However, it has been found that the existing plant cannot be converted to this process without greatly overloading the secondary clarifier. Thus, conventional

aeration is the most feasible process, as recommended. It has been determined that, due to previous overdesign of the aeration tanks, the tankage appears large enough for conventional operation. The existing process (contact-stabilization) theoretically requires less tankage than the conventional mode, but is more difficult to operate, particularly for the way this plant is constructed, is less reliable, and is usually only recommended as a temporary back-up process when extra contact tanks will be used as aeration chambers for conventional operation. Secondary settling will be provided with the existing clarifier. It is imperative that provisions be made for continual sludge wastage, since large volumes of organic sludge are generated with conventional operation. The poor hydraulic characteristics of the settling tank may cause some sludge washout during peak loading periods, especially if proper sludge wastage control is not provided.

Sludge Handling. From 70 to 120 lb. of dry sludge will be produced per day by this plant (a probable wet sludge volume of 1700 to 2800 gallons per day -gpd). Aerobic digestion is recommended for sludge stabilization, and should reduce the waste volume below 600 gpd. This process requires little attention and is not susceptible to upsets. The sludge produced is easily dewatered, and excellent for agricultural application. Power costs are incurred for aeration, and no useful byproduct, such as methane gas, is produced. The simplest technique for sludge drying is open air beds, such as now exist at the plant. Additional bed capacity will probably be needed to accommodate the sludge load and the beds must be covered to allow for winter drying. The alternative to covering the beds would be sludge holding tanks or mechanical dewatering, both of which would be expensive. Dried sludge must be periodically trucked to a landfill site, and could be applied agriculturally if any demand existed.

Chlorination. As discussed elsewhere in this report, it is difficult to attain a high level of disinfection with chlorine and at the same time discharge a low residual. However, the recommended 10,000 gallon backwash tank will provide 4 hours of contact time, which should be sufficient unless the allowable residual discharge limitation is substantially reduced.

Equalization. This process is highly desirable where plant inflows fluctuate greatly, and is also usually recommended to precede filtration, since gravity filters do not operate well under variable flow rates.

Sewage Filtration. In Colorado, sewage plants smaller than .5 mgd must provide a polishing process following biological treatment, since such plants are subject to more exaggerated loadings and consequently are more easily upset. This polishing process can usually be provided with a shallow aerobic pond. However, in mountainous areas where space is not available, a gravity sand filter provides an excellent alternative. Most BOD in secondary effluent is in the suspended form, and

thus filtration will substantially reduce BOD and suspended solids discharge to the receiving stream, making the discharge permit limitations easily attained. Chemical aids are usually needed, and recycled filter backwash water can increase hydraulic loading on the plant by as much as 10 percent.

Ammonia. As stated elsewhere, it is unlikely that ammonia reduction will be required at the Red Cliff Plant. With minimal uptake in the secondary treatment process, a maximum amount of 10 lb. per day would be discharged to the Eagle River. This would probably not affect the allowable ammonia discharge at downstream plants, due to in-stream oxidation and stripping. Ammonia removal at Red Cliff would be expensive, require greater operator attention, and in general would be unrealistic for a plant of this size.

Cold Weather Effects. As discussed elsewhere in this report, cold temperatures severely retard the biological reactions which occur in secondary sewage treatment and aerobic digestion. Also, the oxygen transfer capacity of aeration systems is reduced, and solids settling is hindered. In areas experiencing harsh climates, such as Red Cliff, appropriate design measures must be taken to compensate for these effects. It is absolutely necessary that all processes be enclosed, preferably in a heated building. Other measures include increasing process detention times and over-sizing aeration equipment. The detention times, aeration systems, and other improvements that will be provided with the recommended system should be sufficient to insure adequate treatment at low temperatures. It is likely that, even if enclosed, the efficiency of the aerobic digester will be reduced somewhat during the winter.

Potential Environmental Impacts of the Recommended Plan

Red Cliff occupies portions of a very confined valley floor near the confluence of the Eagle River and Turkey Creek. Because of the narrowness of the valley floor, most of the terrestrial and aquatic habitat within the area has become greatly altered due to human activity. The proposed plan to rehabilitate the Red Cliff sanitary sewage system will have little impact on the ecology of the area. Primary impacts will be temporary changes in water quality due to construction.

Vegetation and Wildlife. Natural vegetation and wildlife is essentially non-existent within the confines of the area which will be disturbed by construction activity. Adverse construction impacts upon local vegetation and wildlife will, therefore, be minimal. Since population in this area is expected to decline in the future, there will be no secondary adverse effects on local wildlife and vegetation normally associated with increased human activity.

Aquatic Biology. Construction associated with the repair and replacement of sewer interceptor lines and the sewage treatment plant improvements may result in a number of potentially adverse effects on the aquatic biota, which are similar to those described for the Upper Eagle Valley sanitation district.

Operation Effects. Implementation of the operational phase of the proposed rehabilitation plan will greatly reduce (1) the volume of total liquid flowing from the plant to the Upper Eagle River system by reduction of infiltration/inflow waters, and (2) the volume of untreated sewage pollutants discharged to the river since most pollutants will be oxidized or removed as sludge. The net effect will be a decrease in water quantity but an increase in water quality, which will be beneficial to the areas' aquatic biota.

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